2024

SIS

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Acknowledgments

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- BITS Pilani K K Birla Goa Campus for hosting the symposium
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Program Schedule

June 17th 2024

08:00 – 09:00 **Registration**

09:00 – 10:00 **Inauguration**
Venue: DLT 9

10:00 – 11:00 **Kash Mittal Awardee Lecture: Prof. Thomas Zemb**
Chairperson: Dr. Kash Mittal
Hydrotropes: weakly SURFace ACTive agENTS but strongly active for solubilization

11:00 – 11:30 **Tea/Coffee break**

Technical Session I (S1)
Venue: DLT 9
Chairperson: Prof. Jaideep Chatterjee

Technical Session II (S2)
Venue: DLT 10
Chairperson: Prof. Sutapa Roy Ramanan

11:30 – 12:00 **The impact of viscosity on dynamic surface tension measurements. A guideline to analyze surfactant solutions of various viscosities. (S1)**
Vivek Kumar[1], JSM Quintero[1], Aleksey Baldygin[1], Paul Molina[1], Thomas Willers[2*], Prashant R. Waghmare[1]

[1]Interfacial Science and Surface Engineering Lab (iSSELab), Department of Mechanical and Aerospace Engineering, Carlerton University, Ottawa, ON, Canada
[2]Applications & Science, KRÜSS GmbH, Borsteler Chaussee 85, 22453 Hamburg, Germany

Unravelling the Anomalous Nature of the Aqueous Nanochannels in Self-assembled Lyotropic Liquid Crystalline Systems (S2)
Konoya Das[1], Bibhisan Roy[1], Subramannyam Sappati[1], Girish S. Bisht[1], Partha Hazra[1]*

[1]Department of Chemistry, Indian Institute of Science Education and Research (IISER) Pune

12:00 – 12:30 **Self-assembly and interactions of bacterial lipids (S1)**
Wuge H. Briscoe[1*]

[1]School of Chemistry, University of Bristol, Cantock's Close, Bristol BS8 1TS, UK

Pickering Emulsion Polymerization Using Amphiphilic Chitin Nanofibers as Stabilizer to Fabricate Nanochitin-based Composite Particles (S2)
Jun-ichi Kadokawa[1]*

[1]Graduate School of Science and Engineering, Kagoshima University, Kagoshima, Japan

12:30 – 12:50 **The influence of copolymeric additives and hydrophobicity dynamics on tailored self-association in p123 micelles (S1)**
Nitumani Tripathi[1], Germán Pérez-Sánchez[2], Nicolas Schaeffer[2], Debes Ray[3,4], Vinod K. Aswal[2], Ketan Kuperkar [1]*, João A. P. Coutinho[2], Pratap Bahadure[5]

[1]Department of Chemistry, Sardar Vallabhbhai National Institute of Technology (SVNIT), Ichchhanath, Surat, 395 007, Gujarat, India (corresponding author)
[2]Department of Chemistry, CICECO, University of Aveiro 3810-193, Aveiro, Portugal
[3]Solid State Physics Division, Bhabha Atomic Research Centre (BARC), Trombay, Mumbai, 400 085, Maharashtra, India.
[4]Biomacromolecular systems and processes, Institute of biological information processing, Forschungszentrum Julich- 52428, Germany.
[5]Department of Chemistry, Veer Narmad South Gujarat University (VNSGU), Udhana-Magdalla Road, Surat, 395 007, Gujarat, India.

Aqueous self-assembly in a zwitterionic-anionic surfactant system: Physicochemical insights (S2)
Mayursing Girase[1] and Ketan Kuperkar[1]

[1]Department of Chemistry, Sardar Vallabhbhai National Institute of Technology (SVNIT), Ichchhanath, Piplod, Surat-395 007, Gujarat, INDIA.

12:50 – 13:10 **Polyol-based deep eutectic solvents (DESs): a new platform for modulating surfactant self-assembly in pure and aqueous environments (S1)**
Yagnik Vora[1,*], Ketan Kuperkar

[1]Department of Chemistry, Sardar Vallabhbhai National Institute of Technology (SVNIT), Ichchhanath, Surat, 395 007, Gujarat, India

Tactile friction under boundary lubrication: Reduction in fingertip friction using surfactants (S2)

Suyash Gairola, Sanjeev Kumar and M.S. Bobji

[1]Indian Institute of Science (IISc Bangalore), Gulmohar Marg, Mathikere, Bengaluru, Karnataka 560012.

13:10 – 14:30 **Lunch + Stalls (Booths) + Networking**

14:30 – 15:30 **Plenary Lecture 1: Prof. Sunil Bhagwat**
Venue: DLT 9
Chairperson: Prof. Santanu Bhattacharya
Title: Surfactants - Synthesis, combinations, reaction media and measurements

Technical Session III (S3)
Venue: DLT 9
Chairperson: Prof. Jingcheng Hao

Technical Session IV (S4)
Venue: DLT 10

Chairperson: Prof. Boris A Noskov

16:00 – 16:30 **Ultra-stable Pickering Liquid Crystal-in Water Emulsions decorated with Thermoresponsive Microgels: An Optical Sensor for Amphiphilic Analytes (S3)**
Abhijit Dan[1]

[1]Department of Applied Chemistry, Maulana Abul Kalam Azad University of Technology, Simhat, Haringhata, West Bengal 741249, India

De-stabilization of oil-droplets adhering to practical solid surfaces with surfactant solutions (S4)
Jaideep Chatterjee[1]

[1]Department of Chemical Engineering, BITS-Pilani, Hyderabad Campus, Telangana, India, 500078.

16:30 – 17:00 **Physicochemical Studies on Amino Acid Based Metallosurfactants in Combination with Phospholipid (S3)**
Manas Barai[1,2], Emili Manna[3], Habiba Sultana[1], Manas Kumar Mandal[1], Tuhin Manna[4], Anuttam Patra[2], Biplab Roy[2], Vasantha Gowda[5], Chien-Hsiang Chang[6], Alexander V. Akentiev[7], Alexey G. Bikov[7], Boris A. Noskov[7], Parikshit Moitra[8], Chandradipa Ghosh[4], Shin-ichi Yusa[9], Santanu Bhattacharya[10,11] and Amiya Kumar Panda [1,*]

[1*]Department of Chemistry, Vidyasagar University, Midnapore - 721102, West Bengal, India

Directed chemical evolution of protein-based surfactants (S4)
Prof. S Sandanaraj Britto

[1] Indian Institute of Science Education and Research (IISER) Pune

17:00 – 17:20 **Synthesis and surface activity of short chain carboxyamide based cationic fluorocarbon and hydrocarbon cationic surfactants as alternatives to PFOA/PFOS (S3)**
Pragya Malik[1,2], IPS Kanwal[2], Durgesh Nandini[2,*], Bijay P. Tripathi[1,*]

[1]Department of Materials Science and Engineering, Indian Institute of Technology Delhi, Hauz Khas, New Delhi-110016, India
[2]Centre for Fire, Explosive and Environment Safety, Defence Research and Development Organisation, Timarpur, Delhi-110054, India

Surfing the Green Wave: Bio Surfactants as Key Players in Environmental Restoration (S4)
Dr. Veena Kumara Adi[1]

[1]Associated professor, Dept of Biotechnology, Bapuji Institute of Engineering and Technology, Davangere 577004, Karnataka, India

17:20 – 17:40 **Synthesis of short chain thioether containing non-ionic Fluorosurfactant and evaluation of its surface activity (S3)**
Versha Joshi[1,2], Durgesh Nandini[2], Roli Purwara[1]

[1]Department of Applied Chemistry, Delhi Technological University, Rohini, New Delhi, 110042
[2]Centre for Fire, Explosive and Environment Safety, Defence Research and Development Organisation, Timarpur, Delhi-110054, India

Remediation of Pyrene contaminated red soil by nZVI (Nano Zero-valent Iron) and SiO_2 (Silica) nanoparticles stabilized Tween 80 (TW80) Surfactant foam (S4)
Ipsita Priyadarshini[1], Chhavi Mishra[1], Arjun R. Shelar[1], Banasri Roy[1], Pradipta Chattopadhyay[1]

[1]Department of Chemical Engineering, Birla Institute of Technology and Science, Pilani-333031, Rajasthan, India

17:40 – 18:00

Human serum albumin conjugated gold nanoparticles non-covalent interactions explored with antioxidants ferulic acid and sinapic acid (S4)
Anjali[1], Nand Kishore[1]

[1]Department of Chemistry, Indian Institute of Technology Bombay, Powai, Mumbai –400076, India

June 18th 2024

09:00 – 10:00

Plenary Lecture 2: Prof. John Texter
Venue: DLT 9
Chairperson: Prof. Srinivas Krishnaswamy
Title: Polymerized Ionic Liquid Surfactants for Advanced Materials

Technical Session V (S5)
Venue: DLT 9
Chairperson: Prof. Kallol K. Ghosh

Technical Session VI (S6)
Venue: DLT 10
Chairperson: Prof. Vivek Rangarajan

10:00 – 10:30

To be announced (S5)
Prof. Jingcheng Hao

Surfactant crystals at gas/liquid interfaces for foam stability (S6)
Prof. Anniina Salonen[1]

[1]Laboratoire de Physique des Solides, Université Paris-Saclay, Orsay, France.

10:30 – 10:50

From Self-Assembly to Drug Delivery: Understanding and Engineering Protein Fibrils by pluronics monomers and micelles (S5)
Anu Jain[1*], and Nand Kishore[1]

[1]Department of Chemistry, Indian Institute of Technology Bombay, Powai, Mumbai – 400076, India

Unravelling Thermodynamics signatures accompanying binding of protein to lipid nanoparticles: A calorimetric and spectroscopic analysis (S6)
Jyoti Rathee[1], Nand Kishore[1]

[1]Department of Chemistry, Indian Institute of Technology Bombay, Powai, Mumbai, India

10:50 – 11:20 **Tea/Coffee break**

Technical Session VII (S7)
Venue: DLT 9
Chairperson: Prof. Soumen Ghosh
Technical Session VII (S7)
Venue: DLT 9
Chairperson: Prof. Soumen Ghosh

Technical Session VIII (S8)
Venue: DLT 10
Chairperson: Prof. Saroj Baral

11:20 – 11:50 **Design and development of novel Micellar catalytic systems for Organophosphate toxicants (S7)**
Kallol Ghosh[1]

[1]School of Studies in Chemistry, Pt. Ravishankar Shukla University, Raipur-492010, Chhattisgarh, India

Lessons learned from modelling surfactants at multiple scales: reverse micelles, emulsions and adsorption (S8)
Maria Sammalkorpi[1]

[1]Aalto University, Finland

11:50 – 12:10 **Probing Surfactant Interactions with Different Interfaces: Case Studies with Nanochitin and Fibrous Nonwoven Fabrics (S7)**
Prottasha Sarker[1], Pallav Jani[1], Anicah Smith O'Brien[1], Orlando J. Rojas[2] & Saad A. Khan[1]

[1]Department of Chemical & Biomolecular Engineering, North Carolina State University, Raleigh, NC 29695-7905, USA
[2]Bioproducts Institute, Department of Chemical & Biological Engineering, The University of British Columbia, Vancouver, British Columbia V6T 1Z3, Canada

Interfacial phenomena in leaching of critical metals from spent lithium-ion battery cathode (S8)
Madhusmita Dash[1,2], Himansu Sekhar Nanda[2*], Soobhankar Pati[1]

[1]Department of Petroleum Engineering, School of Energy Technology, Pandit Deendayal Energy University, Raisan, Gandhinagar, Gujarat 382426, India
[2]Global Sustainable Eco-Solutions, 722 Sharan Circle Hub, Zundal Circle, Zundal, Gandhinagar, Gujarat, 382421, India

12:10 – 12:30

Insight into Surfactant-assisted Enhanced Oil Recovery: Spectroscopic Approach for Understanding Oil Solubilization for Designing Effective Injection Fluid (S7)
Uttam K. Bhui[1] & Rincy Anto[2]

[1]Department of Petroleum Engineering, School of Energy Technology, Pandit Deendayal Energy University, Raisan, Gandhinagar, Gujarat 382426, India
[2]Global Sustainable Eco-Solutions, 722 Sharan Circle Hub, Zundal Circle, Zundal, Gandhinagar, Gujarat, 382421, India

How Zwitterionic Surfactants Affects the Photophysics of Styryl Dye in Triblock Copolymer Assembly with Different PEO and PPO Composition? (S8)
Sapana Sinha[1], Sagar Srivastava[1], Debabrata Seth[1,*]

[1]Department of Chemistry, Indian Institute of Technology Patna, Bihar 801106, India

12:30 – 12:50

Outstanding stability and enhanced activity of Cytochrome-c induced by surfactant in aqueous mixtures of deep eutectic solvent (S7)
Omish Sethi[1], Tejwant Singh Kang[1*], Ashwani Kumar Sood[1*]

[1]Department of Chemistry, UGC Centre for Advance Studies-II, Guru Nanak Dev University, Amritsar, Punjab, India

Phototriggered Drug delivery system of Di-block copolymeric and Spiropyran micelles via NSET mechanism for targeted and real-time drug delivery (S8)
Shalini Dyagala[1], Subit K Saha[1]*

[1]Department of Chemistry, Birla Institute of Technology & Science (BITS) Pilani, Hyderabad Campus, Hyderabad, Telangana 500078, India

12:50 – 14:00 **Lunch + Stalls (booths) + Networking**

14:00 – 19:00 **Excursion**

19:15 – 21:45 **Gala Dinner (Venue: Royal Orchids Beach Resort and Spa, Goa)**

June 19th 2024

09:00 – 10:00

Plenary Lecture 3: Prof. Jong Duk Kim
Venue: DLT 9
Chairperson: Dr. Hrushikesh Mirgal
Title: Internally Networked Nanogels

Technical Session IX (S9)
Venue: DLT 9
Chairperson: Dr. Venkataraghavan

Technical Session X (S10)
Venue: DLT 10
Chairperson: Prof. Konrad Terpilowski

10:00 – 10:30

Effect of non-ionic surfactants on the wetting property of cationic surfactant (S9)

Samiran Mahapatra[1,*], Shanthi Appavoo[1], Vivek Kumar[2], Tulika Bhattachaya[2], Shweta Sharma[2] and Yogesh M Joshi[2,*]

[1]Unilever R&D Bangalore, 64 Main Road, Whitefield, Bangalore 560066, India
[2]Department of Chemical Engineering, Indian Institute of Technology, Kanpur 208016, India

Dynamic surface properties of protein aggregates (S10)

B.A. Noskov[1], A.V. Akentiev[1], A.G. Bykov[1], N.A. Isakov[1], O.Y. Milyaeva[1]

[1]Institute of Chemistry of St. Petersburg State University, St. Petersburg, Russia 198504, Russia, St. Petersburg, Universitetskiy pr. 26

10:30 – 10:50

Biosurfactant production using waste engine oil degrading bacteria pseudomonas aeruginosa gi KP163922: A promising solution for dye removal using nano-adsorbents (S9)

Mohan Jujaru[1], Ayan Bera[1] and Amit Jain[1*]

[1]Department of Chemical Engineering, Birla Institute of Technology and Science, Pilani, Pilani-333031, Rajasthan, India

Innovation of sustainable surfactants: BASF Perspective (S10)

Rohini Gupta[1*], Ashish Taneja[2], Stefan Hirsemann[2], Juergen Tropsch[3], Kati Schmidt[3], Thomas Greindl[3]

[1]Scouting & Collaboration, BASF Corporation, Florham, NJ, United States.

[2]Home Care & Industrial Formulations, Care Chemicals,
Asia Pacific.
[3]Home Care & Industrial Solutions, BASF SE,
Ludwigshafen, Rheinland-Pfalz, Germany.

10:50 – 11:20 **Tea/Coffee break**

Technical Session XI (S11)
Venue: DLT 9
Chairperson: Dr. Samiran Mahapatra

Technical Session XII (S12)
Venue: DLT 10
Chairperson: Prof. Pradeep Kumar Sow

11:20 – 11:50 **Sustainable surfactants: The role for feedstocks, technologies and new chemistries (S11)**
Dr. Venkataraghavan R[1]

[1]Unilever R&D Bangalore, 64, Main Road, Whitefield,
Bangalore 560066

The revised Hydrophilic-Lipophilic Difference for Ionic surfactants (HLDbi): A bridge between formulation practice and surfactant science (S12)
Edgar Acosta[1]

[1]University of Toronto, Department of Chemical Engineering and Applied Chemistry, 200 College Street, Toronto, ON, Canada, M5S3E5

11:50 – 12:10 **Baroplastics: A Deep-Sea-Inspired Path to Sustainable Polymers (S11)**
Prof. Shigeru Deguchi[1]

[1]Japan Agency for Marine-Earth Science and Technology (JAMSTEC), 2Kyoto Institute of Technology, 3Kyoto University

Particle Attributes and Stability of Interfacial Systems in Relation to Pickering Foams (S12)
Sepideh Razavi[1]

[1]Department of Sustainable Chemical, Biological, and Materials Engineering, University of Oklahoma

12:10 – 12:30 **Surface, interfacial and thermodynamic aspects of the biosurfactant-salt systems (S11)**
Lalit M. Pandey[1,2*], Anurag Mishra[2], Pankaj Tiwari[2,3]

[1]Bio-interface & Environmental Engineering Lab, Department of Biosciences and Bioengineering, Indian Institute of Technology Guwahati, Guwahati, Assam, 781039, India
[2]Centre for the Environment, Indian Institute of Technology Guwahati, Guwahati, Assam, 781039, India
[3]Department of Chemical Engineering, Indian Institute of Technology Guwahati, Guwahati, Assam, 781039, India

Enhancing gas hydrate kinetics using surfactants for desalination applications (S12)
Nagaraju Perapu[1], Srinivas Krishnaswamy[1*], Rajnish Kumar[2]

[1]Birla Institute of Technology and Science (BITS) Pilani, Goa. [2]Indian Institute of Technology – Madras.

12:30 – 12:50 **Exploring the influence of surfactant collector bath characteristics on the morphology of electrospun polystyrene magnetite composite fibers (S11)**
Aakanksha Mohan[1], Sutapa Roy Ramanan[1,*]

[1]Department of Chemical engineering, BITS Pilani K K Birla Goa Campus, India

Flotation separation of ABS/PS flakes mixture from used refrigeration equipment (S12)
Benita Malinowska[1,2], Konrad Terpiłowski[2]

[1]Polish Recycling Corporation
[2]Maria Curie-Sklodowska University of Lublinj, Department of Interfacial Phenomena

12:50 – 14:30 **Lunch + Stalls (Booths) + Networking**

14:30 – 15:30 **Plenary Lecture 4: Prof. Calum J. Drummond**
Venue: DLT 9
Chairperson: Prof. S. S. Bhagwat
Title: Amphiphile Self-Assembly Driving Force, Structure Formation, and Applications

15:30 – 16:00 **Tea/Coffee Break**

Technical Session XIII (S13)
Venue: DLT 9
Chairperson: Dr. Subit Kumar Saha

Technical Session XIV (S14)
Venue: DLT 10
Chairperson: Prof. Amiya K. Panda

16:00 -16:30

Leveraging surfactant and particle & powder technologies for enhanced performance in industrial applications (S13)
Brij M. Moudgil[1]

[1] Department of Materials Science and Engineering,
University of Florida, Gainesville, FL 32653, USA

Characterizations of vesicular structures fabricated from a Pseudotriple-Chainedi ion pair amphiphile (S14)
Jia-Rong Lin[1] and Chien-Hsiang Chang[1]*

[1] Department of Chemical Engineering, National Cheng
Kung University, Tainan 701, Taiwan

16:30 – 17:00

Novel polymeric aqueous dispersant – Atlox 4917 (S13)
Hrushikesh J. Mirgal[1]

[1] Croda India

Photo-induced fast and reversible morphological changes in micelles formed by amphiphilic Lophine dimers and their evaluation by insitu SANS measurement (S14)
Hideki Sakai[1,*], Masaaki Akamatsu[2]

[1] Faculty of Science and Technology, Tokyo University of
Science, 2641 Yamazaki, Chiba 278-8510, Japan
[2] Faculty of Engineering, Tottori University, 4-101 Koyama-
cho Minami, Tottori 680-8550, Japan.

17:00 – 17:20

Hybrid hydrogel sorbents based on natural polysaccharides for extraction of dyes from aqueous solutions (S13)
Benita Malinowska[1,2], Konrad Terpiłowski[2]

[1] Polish Recycling Corporation
[2] Maria Curie-Sklodowska University of Lublinj, Department
of Interfacial Phenomena

Challenges in the design and optimization of the surfactant - based delivery systems (S14)
Prof. Santanu Bhattacharya[1,2,3]

[1] Indian Institute of Science, Education & Research, Tirupati,
INDIA
[2] Department of Organic Chemistry, Indian Institute of
Science, Bangalore 560012, India
[3] School of Interdisciplinary Sciences, Indian Association for
the Cultivation of Science, Kolkata 700 032, India.

17:20 – 18:20 **Poster Sessions**

Effect of gemini surfactant alkyl chain length on self-assembly properties of POE-based nonionic surfactants micellar behavior: An in-depth of scattering study
Virendra Prajapati[1] , Ketan Kuperkar[1*] , Pratap Bahadur[2]

[1]Department of Chemistry, Sardar Vallabhbhai National Institute of Technology (SVNIT), Ichchhanath Dumas Road, Keval Chowk, Surat-395007, Gujarat, INDIA.
[2]Department of Chemistry, Veer Narmad South Gujarat University (VNSGU), Udhna-Magdalla Road, Surat-395007, Gujarat, INDIA.

Determining the mechanisms of the micellization as well as the interactions between molecules within a combination of surfactants mixture
Tejash Desai[1] and Ketan Kuperkar[1]*

[1]Department of Chemistry, Sardar Vallabhbhai National Institute of Technology (SVNIT), Ichchhanath, Surat, 395 007, Gujarat, INDIA.

Co-solvent and Co-surfactant effect of some alkanols and alkanediols on Micellization of a cationic gemini surfactant in aqueous solutions.
Dr. Sureshkumar L. Chavda[1]

[1]Dr. A P J Abdul Kalam Government College, Dadra and Nagar Haveli Ucchh Shikshya Samit, Silvassa, UT of Dadra and Nagar Haveli and Daman and Diu (College is affiliated with Gujarat University, Ahmedabad)

Formation of ethanolamine-mediated surfactant-free microemulsions using hydrophobic deep eutectic solvents
Anjali[1] and Siddharth Pandey[1]*

[1]Department of Chemistry, Indian Institute of Technology Delhi, Hauz Khas, New Delhi – 110016, India.

Aggregates in deep eutectic solvents (DESs): Hydrophilic DES-in-hydrophobic DES novel nonaqueous microemulsions
Anushis Patra, Anjali and Siddharth Pandey*

The "Normalized HLD": The Ultimate Version of the Hydrophilic-Lipophilic-Deviation Equation for Characterizing and Formulating Surfactant/Oil/Water Systems

Prof. Jean-Marie Aubry[1]

Nano Zero-valent Iron (nZVI) stabilized APG (Alkyl Polyglycoside) Surfactant Foam for the remediation of Acephate in Alluvial soil

Ipsita Priyadarshini[1], Chhavi Mishra[1], Banasri Roy[1], Pradipta Chattopadhyay[1]

[1]Department of Chemical Engineering, Birla Institute of Technology and Science, Pilani-333031, Rajasthan, India

Waste plastic as a feedstock for producing surfactants

Apeksha Ramesh[1], Arvind Bhure[1] and Venkataraghavan R[1]

Unilever R&D Bangalore, 64, Main Road, Whitefield, Bangalore 560066

Tunable catalytic activity of mixed micelle for the oxidation of benzyl alcohol in aqueous media

Priya Karmakar[1], Ujjwal Mandal[1,*], Bidyut Saha[1,*]

[1]Surfactant Chemistry Laboratory, Department of Chemistry, The University of Burdwan, Burdwan-713104, West Bengal, India

How Polyoxometalates Promote the Aggregation of Cyanine Dyes in the Aqueous Solution of Non-Ionic Copolymers of Varying Hydrophilic–Lipophilic Balance?

Sanyukta Bhattacharjee[1] , Debabrata Seth[1*]

[1]Department of Chemistry, Indian Institute of Technology Patna, Patna 801103, Bihar, India

Light-triggered emulsion formation using a protonated merocyanine as a surfactant

Kyosuke Arakawa[1], Natsuna Hosokawa[1], Kenichi Sakai[1], Hideki Sakai[1]

[1]Tokyo University of Science, Department of Pure and Applied Chemistry Chiba 278- 8510, Japan.

Effect of Oil Type on the Viscoelastic Behavior of Surfactant Film Formed at Oil/Water Interface

Hiroki Kuwabara[1,2], Kyosuke Arakawa[1], Koji Tsuchiya[1], Kenichi Sakai[1], Hideki Sakai[1]

[1]Tokyo University of Science
[2]IKEDAMOHANDO

Role of surfactants on PLA/HA microspheres size and implications for azithromycin release

Shivi Tripathi[1,2], Harpreet Singh[3], Himansu Sekhar Nanda[1,2,4*]

[1]Biomedical Engineering and Technology Laboratory, Discipline of Mechanical Engineering, PDPM Indian Institute of Information Technology Design and Manufacturing Jabalpur, Dumna Airport Road, Jabalpur, Madhya Pradesh 482005, India
[2]International Centre for Sustainable and Net Zero Technologies, PDPM-Indian Institute of Information Technology Design and Manufacturing Jabalpur, Dumna Airport Road, Jabalpur, Madhya Pradesh 482005, India
[3]Discipline of Mechanical Engineering, Dr B R Ambedkar National Institute of Technology Jalandhar, Amritsar, Bypass Road, Jalandhar, Punjab 144011, India
[4]Terasaki Institute for Biomedical Innovation (TIBI), 21100 Erwin St Los Angeles, CA 91367, USA

Isolation, Screening and Construction of a Microbial Consortium from Formation Water and its suitability for MEOR

Shilpa Nandi[1], Lalit M. Pandey[1,2], Pankaj Tiwari[1,3]

[1]Centre for the Environment, Indian Institute of Technology Guwahati, Guwahati 781039, Assam, India
[2]Department of Biosciences and Bioengineering, Indian Institute of Technology Guwahati, Guwahati 781039, Assam, India
[3]Department of Chemical Engineering, Indian Institute of Technology Guwahati, Guwahati 781039, Assam, India

Exploring the Solubilization Behavior of Gelucire® 48/16 and Tetronics® 1304: A Molecular Perspective

Deep Bhalani[1], Sadafara A. Pillai[1]

[1,2]School of Sciences, P P Savani University, Surat-394125

Understanding the Influence of Organic Additives on Phase Behavior and Microstructure: A Comparative Study of Soluplus and Solutol® HS15 Micellar Systems

Gaurang Dalsaniya[1], Sadafara A. Pillai[2]
[1,2]School of Sciences, P P Savani University, Surat-394125

Understanding the Interaction Between Ionic Liquids and Amphiphilic Star Block Copolymers

Jyoti Vyas[1], Sadafara A. Pillai[2]

[1,2]School of Sciences, P P Savani University, Surat-394125

The effect of ethoxylated alcohols on the sedimentation rate of calcium carbonate. Potential for use in flotation separation of plastics
Benita Malinowska[1,2], Konrad Terpiłowski[2]

[1]Polish Recycling Corporation
[2]Maria Curie-Sklodowska University of Lublin, Department of Interfacial Phenomena

Enhancing Emulsion Stability for Oil Recovery: The Synergistic Effects of Surfactants, Nanoparticles, and Polymers
S. Aidarova[1], F. Amankeldi[2], A. Sharipova[3]

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[2]Al-Farabi Kazakh National University, Almaty, Kazakhstan
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Saponins in Pithecellobium dulce: Structural Diversity and Surface-Active Potential
Susmita Gudulkar[1], Dr. Himanshu Dawda[1], Dr. Usha Mukudan

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June 20th 2024

Technical Session XV (S15)
Venue: DLT 9
Chairperson: Dr. Saurabh Patankar

09:00 – 09:30

Structural effect of surfactants on the compaction of ct-DNA in the presence of silica nanoparticles: Presenting highly efficient gene delivery vectors
Shalini Dyagala[1], Milan Paul[2], Vinod K Aswal[3], Swati Biswas[2], Subit Kumar Saha[1]*

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Mumbai, Maharashtra 400085, India

09:30 – 10:00

Structure-Property-Energetics relationships in drug partitioning and release employing colloidal self-assemblies: mechanistic insights
Nand Kishore[1]

[1]Department of Chemistry, Indian Institute of Technology Bombay, Mumbai – 400 076, India

10:00 – 10:30	**Valedictory and Vote of Thanks** **Venue: DLT 9**

Kash Mittal Awardee Lecture

Chairperson: Dr. Kash Mittal

Hydrotropes: weakly SURFace ACTive agENTS but strongly active for solubilization

Thomas Zemb[1]

[1]ICSM Marcoule, France

We will first briefly review knowledge gained in the last twenty years about the molecular mechanisms behind phenomenon of hydrotropy.

Entropy in ternary solutions is at the origin of the dynamic aggregates are present near phase boundaries. These can be traced by small angle X-ray scattering, small angle neutron scattering and also Rayleigh light scattering. These dynamic aggregates - that exist far form critical points- were proposed theoretically to exist without any surfactant by H Reiss in 1975. Triggered by a explicit call expressed by Kash Mittal the same year, there experimentally discovered by RE Barden only one year later, in 1976. They are since then reported in the literature using a large set of names: SFME, pre-ouzo aggregates, UFME standing for ultra-flexible microemulsions, mesoscopic solubilization.

Understanding nature of the liquid-liquid phase transition in ternary systems with weak mesoscopic structuration allows to explain the mechanism behind the efficiency of the popular Bligh and Dyer protocol for extraction of lipids in cell biology as well as the pre-concentration in the dispersive liquid-liquid microextraction (DLLME) used in analytical chemistry.

From this understanding, we will show how to use hydrotropes in formulations of extracting molecular systems to make considerably greener, faster and cheaper metal extraction necessary for recycling.

TECHNICAL SESSION I

Invited Lectures

Chairperson: Prof. Jaideep Chatterjee

11:30 – 12:00 **The impact of viscosity on dynamic surface tension measurements. A guideline to analyze surfactant solutions of various viscosities.**
Vivek Kumar[1], JSM Quintero[1], Aleksey Baldygin[1], Paul Molina[1], Thomas Willers[2,*], Prashant R. Waghmare[1]

[1]Interfacial Science and Surface Engineering Lab (iSSELab), Department of Mechanical and Aerospace
Engineering, Carlerton University, Ottawa, ON, Canada
[2]Applications & Science, KRÜSS GmbH, Borsteler Chaussee 85, 22453 Hamburg, Germany

12:00 – 12:30 **Self-assembly and interactions of bacterial lipids**
Wuge H. Briscoe[1,*]

[1]School of Chemistry, University of Bristol, Cantock's Close, Bristol BS8 1TS, UK

Oral Presentation

12:30 – 12:50 **The influence of copolymeric additives and hydrophobicity dynamics on tailored self-association in p123 micelles**
. Nitumani Tripathi[1], Germán Pérez-Sánchez[2], Nicolas Schaeffer[2], Debes Ray[3,4], Vinod K. Aswal[2], Ketan Kuperkar [1]*, João A. P. Coutinho[2], Pratap Bahadure[5]

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12:50 – 13:10 **Polyol-based deep eutectic solvents (DESs): a new platform for modulating surfactant self-assembly in pure and aqueous environments**
Yagnik Vora[1, *], Ketan Kuperkar

[1]Department of Chemistry, Sardar Vallabhbhai National Institute of Technology (SVNIT), Ichchhanath, Surat, 395 007, Gujarat, India

THE IMPACT OF VISCOSITY ON DYNAMIC SURFACE TENSION MEASUREMENTS. A GUIDELINE TO ANALYZE SURFACTANT SOLUTIONS OF VARIOUS VISCOSITIES.

Vivek Kumar[1], JSM Quintero[1], Aleksey Baldygin[1], Paul Molina[1], Thomas Willers[2,*], Prashant R. Waghmare[1]

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Dynamic surface tension (DST) measurements are vital for varied viscous fluids with surface active agents, such as low viscous ink-jet inks and high viscous resin-based lacquers. The transient dynamics of surfactants and the viscous nature of the liquid are vital for optimizing the corresponding dynamic processes in various industries. Theoretically, surface tension is independent of viscosity including DST, which is measured as a function of time after a new surface was created known as the surface age. However, the time after which a new surface has flown to its equilibrium shape depends on viscosity. The measured surface tension value is only valid when this flow process is complete; therefore, this relaxation time is the limit for the smallest reasonable surface age measured. Any DST behavior at younger surface ages could be wrongly interpreted as being purely surfactant driven. Here we empirically determined the smallest possible surface age for all commonly used DST measurement methods for fluids of given viscosities. We discuss differences between viscous and inertial time scales. Based on this we present a guideline type phase plot facilitating to select the most appropriate method and the youngest accessible surface age for a correct DST measurement not being falsified by viscosity effects. Interestingly, the bubble pressure method as being the "gold standard" for DST measurements is not always the most appropriate method. With the presented phase plot scientist can now assure that the observed dynamic behaviour in the DST measurement only describes the surfactant behaviour and is not falsified by viscosity effects.

Keywords: Dynamic surface tension (DST), viscous effect, equilibrium/relaxation time, surface age, hydrodynamic forces, diffusion coefficient

SELF-ASSEMBLY AND INTERACTIONS OF BACTERIAL LIPIDS

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Lipopolysaccharides (LPS)[1] and lipoteichoic acid (LTA)[2,3] are major components in the membranes of Gram-negative and Gram-positive bacteria, respectively, and their ingeniously-designed molecular architectures are very different from common synthetic surfactants and phospholipids.

Small angle neutron scattering (SANS) has revealed a rich variety of morphologies of the self-assembled structures, such as micelles, worms, and vesicles of different geometries, by these bacterial lipids in solution, complementing direct measurement[4] of interactions between model bacterial membranes using the surface force apparatus (SFA)[5-7]. The classic Langmuir-Blodgett (LB) trough technique has unveiled quasi-equilibrium and dynamic elastic properties of the bacterial lipid monolayer, correlating with in situ X-ray and neutron reflectivity characterization of its nano-structure. Such detailed knowledge of bacterial lipid self-assembly in solution and at interfaces is critical to understanding their roles in causing sepsis and to future rational design of novel antimicrobial strategies[8].

Keywords: Self-assembly, bacterial lipids, membranes, surface force apparatus (SFA), small-angle neutron scattering (SANS), X-ray reflectivity (XRR), and Langmuir-Blodgett (LB) trough

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THE INFLUENCE OF COPOLYMERIC ADDITIVES AND HYDROPHOBICITY DYNAMICS ON TAILORED SELF-ASSOCIATION IN P123 MICELLES

Nitumani Tripathi[1], Germán Pérez-Sánchez[2], Nicolas Schaeffer[2], Debes Ray[3,4], Vinod K. Aswal[2], Ketan Kuperkar [1]*, João A. P. Coutinho[2], Pratap Bahadure[5]

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The study explores the impact of diverse lipophilic compounds on the physical attributes of Pluronic micelles, with a specific focus on the thermoresponsive triblock copolymer (BCP) known as Pluronic® P123. The objective is to improve the solution behavior of Pluronic P123 by introducing additional BCPs with a consistent propylene oxide (PO) series and different degrees of hydrophilicity, encompassing L61, L62, L64, and F68 (%EO content). The observed clouding behavior reflects the phase behavior of mixed micelles formed by these copolymers. Characterization of the micelles formed by single and mixed BCPs is conducted using dynamic light scattering (DLS) and small-angle neutron scattering (SANS) methods as a function of temperature. These techniques provide valuable insights into micelle size and shape. The size variations in self-assembled mixed micelles are analysed to comprehend the impact of additives on micelle structure. Results indicate that with increasing temperature, micelles undergo various shape transitions, evolving from spherical to ellipsoidal or rod-like to vesicle, as confirmed by molecular dynamics (MD) simulations. The simulations provide confirmation that the interactions between Pluronic-Pluronic mixed micelles are effective. Consequently, the integration of experimental findings with MD simulations yields a comprehensive understanding of the molecular mechanisms governing micelle aggregation within the examined system.

Keywords: Pluronics®; Cloud point (CP); scattering; molecular dynamics (MD); micellar transition.

POLYOL-BASED DEEP EUTECTIC SOLVENTS (DESs): A NEW PLATFORM FOR MODULATING SURFACTANT SELF-ASSEMBLY IN PURE AND AQUEOUS ENVIRONMENTS

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Deep Eutectic Solvents (DESs) are widely accepted as ecologically benign solvents in numerous applications due to their high environmental sustainability and biodegradability. For this study, we employed polyhydric alcohols such as ethylene glycol (EG), diethylene glycol (DEG), triethylene glycol (TEG), and glycerol (Gly) as hydrogen bond donors (HBDs), along with choline chloride (ChCl) as the hydrogen bond acceptor (HBA). These components were carefully mixed in appropriate molar ratios to produce stable deep eutectic solvents (DESs). The intentional addition of water to the pure DESs has been acknowledged as a quick and efficient method to alter the chemical and thermodynamic properties of DESs. To examine the significant alterations in the intrinsic composition of the prepared DESs when water is added, we utilized FT-IR and ^{1}H-NMR spectroscopic methods. Our results indicate that DESs have a significant thermodynamic recognition for the formation of micelles, which is attributed to their hydrogen-bonded nanostructure. Nevertheless, this phenomenon appears to be heavily reliant on the particular composition of the DES, the amount of water added, and the surfactant used. This study investigates the procedure of micellization demonstrated through a positively charged surfactant, Dodecyl trimethylammonium bromide (DTAB), in both pure DESs and a mixture of DESs with water. The phenomena were elucidated using surface tension measurements, dynamic light scattering (DLS), and small-angle X-ray scattering (SAXS) methods. In addition, a thorough investigation of the molecular-level characteristics and behavior of DESs was conducted using computational semiempirical method simulations with Gaussian software version 5.0.9.

Keywords: Deep Eutectic Solvents (DESs); surfactant; spectral; scattering; computational simulation

TECHNICAL SESSION II

Invited Lectures

Chairperson: Prof. Sutapa Roy Ramanan

11:30 – 12:00 **Unravelling the Anomalous Nature of the Aqueous Nanochannels in Self-assembled Lyotropic Liquid Crystalline Systems**

Konoya Das[1], Bibhisan Roy[1], Subramannyam Sappati[1], Girish S. Bisht[1], Partha Hazra[1]*

[1]Department of Chemistry, Indian Institute of Science Education and Research (IISER) Pune

12:00 – 12:30 **Pickering Emulsion Polymerization Using Amphiphilic Chitin Nanofibers as Stabilizer to Fabricate Nanochitin-based Composite Particles**

Jun-ichi Kadokawa[1]*

[1]Graduate School of Science and Engineering, Kagoshima University, Kagoshima, Japan

Oral Presentation

12:30 – 12:50 **Aqueous self-assembly in a zwitterionic-anionic surfactant system: Physicochemical insights**

Mayursing Girase[1] and Ketan Kuperkar[1]

[1]Department of Chemistry, Sardar Vallabhbhai National Institute of Technology (SVNIT), Ichchhanath, Piplod, Surat-395 007, Gujarat, INDIA.

12:50 – 13:10 **Tactile friction under boundary lubrication: Reduction in fingertip friction using surfactants**

Suyash Gairola, Sanjeev Kumar and M.S. Bobji

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UNRAVELLING THE ANOMALOUS NATURE OF THE AQUEOUS NANOCHANNELS IN SELF-ASSEMBLED LYOTROPIC LIQUID CRYSTALLINE SYSTEMS

Konoya Das[1], Bibhisan Roy[1], Subramannyam Sappati[1], Girish S. Bisht[1], Partha Hazra[1]*

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Lyotropic liquid crystals (LLCs), a class of ‘soft’ materials, are self-assembled nanostructures of water and lipids, exhibiting properties intermediate between isotropic liquids and solid crystals.[1] LLCs exhibit rich polymorphism as a function of water content and temperature. These materials have gained substantial popularity in the last decade owing to their promising applications in material science and engineering, biology, nano chemistry, pharmaceutical industry etc.[2] A molecular-level understanding of the aqueous LLC channels is essential to bridge the gap with the macroscopic functions of the materials to enhance their performance.

In this talk, various excited state phenomena have been utilized to study the behaviour of the LLC water molecules and the different factors governing their molecular properties. Firstly, I will mainly focus on the impact of topology on the micro polarity, micro viscosity, and the hydration dynamics of the water molecules in the two cubic mesophases, gyroid (Ia3d) and diamond (Pn3m).[3] Subsequently, the hydrogen bond accepting and donating parameters in the aqueous LLC domains of the inverse hexagonal (H_{II}) and the cubic phases (Pn3m and Ia3d) were estimated by the phenomenon of excited state intramolecular proton transfer.[4]

In the following study, the simultaneous interplay between the effects of micro polarity and hydrogen bonding abilities of the LLC water molecules was evaluated by the unique multi-parametric sensitivity of the excited state proton coupled electron transfer phenomenon.[5] All the studies indicate that the different physical aspects of the water molecules exhibit a location-dependent behaviour inside the aqueous channels, pointing towards the presence of multiple discrete water networks.

Keywords: Lyotropic Liquid Crystal, Self-assembly, Water Nano-channel, Photophysics

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PICKERING EMULSION POLYMERIZATION USING AMPHIPHILIC CHITIN NANOFIBERS AS STABILIZER TO FABRICATE NANOCHITIN-BASED COMPOSITE PARTICLES

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Because chitin is a natural polysaccharide abundantly present on the earth, its effective utilization as the biomass resource has attracted much attention to obtain new bio-based materials. Previously, we reported that regeneration from a chitin ion gel using methanol fabricated self-assembled chitin nanofibers (ChNFs). On the other hand, Pickering emulsion is an emulsion, in which solid materials are used as emulsion stabilizers in place of surfactants. In this study, we performed Pickering emulsion polymerization of styrene using the ChNFs as stabilizer. The ChNFs were first modified by anionic maleyl groups to provide amphiphilicity and simultaneously enhance dispersibility in aqueous media. After styrene was mixed with the amphiphilic ChNFs/aqueous ammonia dispersion, the mixture was subjected to ultrasonication to obtain an emulsion, where styrene droplets were surrounded by the ChNFs. Radical polymerization was then conducted in the presence of $K_2S_2O_8$ as initiator in the emulsion to form the nanochitin-based composite particles. We then attempted the conversion of the composite particles into hollow particles by dissolving out inner polystyrene using toluene. The resulting hollow particles, however, were poorly stable under re-dispersion condition in water. To improve stability of the hollow particles, polymerizable methacryl groups were additionally introduced on ChNFs to add ability to copolymerize with styrene. Hollow particles, which were fabricated using the obtained multifunctional ChNFs by the similar procedure to the above Pickering emulsion polymerization, were re-dispersed well in water, while maintaining their morphology. Furthermore, a pyrene dye could be encapsulated in cavities of the hollow particles by hydrophobic interaction.

Keywords: amphiphilic; chitin nanofiber; composite particle; nanochitin; Pickering emulsion polymerization

AQUEOUS SELF-ASSEMBLY IN A ZWITTERIONIC-ANIONIC SURFACTANT SYSTEM: PHYSICOCHEMICAL INSIGHTS

Mayursing Girase[1] and Ketan Kuperkar[1]

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Using tensiometry, rheology, and small-angle neutron scattering (SANS), this study investigates the micellization and morphology transition in the mixed micellar system of zwitterionic surfactant: dodecyl dimethylammonium propane sulfonate ($C_{12}PS$) and anionic surfactant: sodium dodecyl sulphate (SDS). SDS had a significant effect on $C_{12}PS$ micelles. The information about minimum area per molecule (A_{min}) and maximum surface excess concentration (Γ_{max}) was obtained from surface tension vs *ln C* isotherm. The critical micelle concentration (CMC) values of the investigated systems were used to compute the interaction parameter (β) by using regular solution theory (RST) that depicted synergism in systems at mole fractions beyond 0.5 of $C_{12}PS$. We have also studied the influence of various electrolytes (salts) on mixed micellar systems. Another aspect that modifies the micellization and adsorption capabilities of zwitterionic surfactants in the being of added electrolyte is the specific binding of anions and the cation of the added electrolyte (NaCl). Here, the varied solution behaviour such as viscous, highly viscous, viscoelastic and gel formation were scrutinized from rheological measurements in the presence of salts. The scattering study inferred the micellar growth/transition occurrences upon addition of SDS in $C_{12}PS$ in presence of salt and as a function of temperature.

Keywords: Mixed surfactant system; synergism; rheology; scattering; computational simulation

TACTILE FRICTION UNDER BOUNDARY LUBRICATION: REDUCTION IN FINGERTIP FRICTION USING SURFACTANTS

Suyash Gairola[1], Sanjeev Kumar[1] and M.S. Bobji[1]

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Tactile exploration involves dynamic interactions between fingertips and object surfaces, governed by both normal and frictional forces. To understand these interactions, the friction between a patterned, deformable soft substrate and a rigid substrate under boundary lubrication by human fingers was investigated. This study has potential applications in areas like tactile sensing, haptic devices, prosthetics and design of textiles and FMCG goods. Using a custom-built strain gauge sensor, both normal and frictional forces were measured simultaneously and independently for various lubricating solutions applied to the fingertip interacting with a glass substrate. The results demonstrate a significant reduction in friction upon introducing a surfactant acting as a lubricant as compared to dry contact. Solutions containing surfactants, like Sodium Dodecyl Sulfate (SDS), exhibit efficient boundary lubrication, achieving Coefficient of Friction (COF) values as low as 0.2 at high concentrations. Notably, COF exhibits an asymptotic behaviour beyond the surfactant's critical micellar concentration, suggesting saturation of the interface. Further, the COF-time profile changes its nature from flat to decaying as the bulk concentration increases. Experiments indicate the adsorption of surfactant molecules onto the surfaces as the cause for the decaying nature of the COF-time profiles.

Keywords: Tactile friction, Boundary lubrication, Coefficient of friction, Surfactant, Adsorption

PLENARY LECTURE 1

Chairperson: Prof. Santanu Bhattacharya

SURFACTANTS - SYNTHESIS, COMBINATIONS, REACTION MEDIA AND MEASUREMENTS

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New entrants
The ever expanding search for new surfactant materials based on materials and with higher biodegradability led us to some sophorolipids, surfactants based on Cashew-nut shell liquid, bi-phosphate gemini and amido amine based gemini molecules. Some exhibited unusual properties alone some with combinations.

Team-work
Interesting properties develop due to the micelle- monomer composition when mixed surfactants are used. Some molecules when added to a surfactant lead to drastic property changes at small proportions.

Change path and speed
Surfactants influence kinetics through solubilization in micelles and sometimes even without involvement of micelles. Nanoparticle size can be engineered with nanostructured media like microemulsions. Product distribution is affected selectivity can be tailored in many cases owing to orientation effects.

Foam - how much?
Foamability is an important property sometimes needing elimination or sometimes enhancement. Accurate and reproducible measurement is important for industrial formulations. A new instrument was developed which satisfies both the needs.

TECHNICAL SESSION III

Invited Lectures

Chairperson: Prof. Jingcheng Hao

16:00 – 16:30 **Ultra-stable Pickering Liquid Crystal-in Water Emulsions decorated with Thermoresponsive Microgels: An Optical Sensor for Amphiphilic Analytes**
Abhijit Dan[1]

[1]Department of Applied Chemistry, Maulana Abul Kalam Azad University of Technology, Simhat, Haringhata, West Bengal 741249, India

16:30 – 17:00 **Physicochemical Studies on Amino Acid Based Metallosurfactants in Combination with Phospholipid**
Manas Barai[1,2], Emili Manna[3], Habiba Sultana[1], Manas Kumar Mandal[1], Tuhin Manna[4], Anuttam Patra[2], Biplab Roy[2], Vasantha Gowda[5], Chien-Hsiang Chang[6], Alexander V. Akentiev[7], Alexey G. Bikov[7], Boris A. Noskov[7], Parikshit Moitra[8], Chandradipa Ghosh[4], Shin-ichi Yusa[9], Santanu Bhattacharya[10,11] and Amiya Kumar Panda [1,*]

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Oral Presentation

17:00 – 17:20 **Synthesis and surface activity of short chain carboxyamide based cationic fluorocarbon and hydrocarbon cationic surfactants as alternatives to PFOA/PFOS**
Pragya Malik[1,2], IPS Kanwal[2], Durgesh Nandini[2,*], Bijay P. Tripathi[1,*]

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[2]Centre for Fire, Explosive and Environment Safety, Defence Research and Development Organisation, Timarpur, Delhi- 110054, India

17:20 – 17:40 **Synthesis of short chain thioether containing non-ionic Fluorosurfactant and evaluation of its surface activity**
Versha Joshi[1,2], Durgesh Nandini[2], Roli Purwara[1]

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ULTRA-STABLE PICKERING LIQUID CRYSTAL-IN-WATER EMULSIONS DECORATED WITH THERMORESPONSIVE MICROGELS. AN OPTICAL SENSOR FOR AMPHIPHILIC ANALYTES

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Micrometer-sized droplets of thermotropic liquid crystals (LCs) dispersed in aqueous media (i.e., LC-in-water emulsions) respond sensitively to the presence of a variety of different analytes that trigger changes in the configurations of the LC within the droplets.1 Herein, we present a novel approach that involves Pickering stabilization of micometer-sized liquid crystal (LC) droplets with soft colloidal particles known as polymeric microgels to facilitate the analysis of analyte-induced configurational transition of the LC droplets. The microgel particles are able to irreversibly adsorb at the LC−water interface, and the resulting microgel-stabilized LC droplets possess a remarkable stability against coalescence over time. Although, the LC droplets are successfully protected by a continuous network of the microgel layer, the LC-water interface is still accessible for amphiphilic analytes, such as such as anionic sodium dodecyl sulfate (SDS) and cationic dodecyl trimethylammonium bromide (DTAB) that can diffuse through the meshes of the adsorbed microgel network or through the interfacial pores and induce an LC response. This approach is exploited to investigate the dynamic range of the microgel-stabilized LC droplet response to analytes. The LC-in-water emulsions can be broken at temperature slightly above the volume phase transition temperature (VPTT) of the microgels that results macroscopic phase separation, thereby leading to recycling of the emulsifiers.2 The combination of excellent emulsion stability and breaking on-demand, the responsivity of the droplets and the reusability of the emulsifier offers a complete and versatile toolbox for sustainable application of chemical and biological sensing.

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PHYSICOCHEMICAL STUDIES ON AMINO ACID BASED METALLOSURFACTANTS IN COMBINATION WITH PHOSPHOLIPID

Manas Barai[1,2], Emili Manna[3], Habiba Sultana[1], Manas Kumar Mandal[1], Tuhin Manna[4], Anuttam Patra[2], Biplab Roy[2], Vasantha Gowda[5], Chien-Hsiang Chang[6], Alexander V. Akentiev[7], Alexey G. Bikov[7], Boris A. Noskov[7], Parikshit Moitra[8], Chandradipa Ghosh[4], Shin-ichi Yusa[9], Santanu Bhattacharya[10,11] and Amiya Kumar Panda [1,*]

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Dicarboxylate metallosurfactants (AASM), synthesized by stoichiometric mixing of N-dodecyl amino-malonate, -aspartate and -glutamate with bivalent metal salts (CaCl2, MnCl2 and CdCl2) were characterized by FTIR, 1HNMR and 13C MAS NMR spectroscopy. XRD data confirm the formation of layered structures. Phase transition and associated weight loss of AASMs were investigated by differential scanning calorimetry and thermogravimetric analysis. Solvent-spread mixed monolayers of AASM, soyphosphatidylcholine (SPC) and cholesterol (CHOL) were studied using Langmuir surface balance. With increasing mole fraction of AASM mean molecular area increased, indicating molecular packing reorganization. Systems with 20 and 60 mol% AASM exhibited positive deviations from ideal behavior signifying repulsive interaction, while synergistic interactions were established from the negative deviation at other combinations. Dynamic surface elasticity increased with increasing surface pressure signifying formation of rigid monolayer. Brewster angle microscopic analyses suggest transition of monolayer from gaseous to liquid expanded to liquid condensed state. Stability of the hybrid vesicles, formed by AASM+SPC+CHOL, were established by their size, zeta potential and polydispersity index values over 100 days. Spherical morphology of the hybrid vesicles were evidenced by transmission electron microscope. Vesicles were biocompatible, as revealed from the cytotoxicity studies; thus they can have applications in drug delivery and imaging.

SYNTHESIS AND SURFACE ACTIVITY OF SHORT CHAIN CARBOXYAMIDE BASED CATIONIC FLUOROCARBON AND HYDROCARBON CATIONIC SURFACTANTS AS ALTERNATIVES TO PFOA/PFOS

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Long-chain perfluorocarbon surfactants like perfluorooctanoic acid (PFOA) or perfluorooctane sulphonate (PFOS) are few of the most well-known fluorosurfactants which are indispensable for use in many fields. However, their associated environmental concerns like bioaccumulation, toxicity and persistence have lead to many restrictions imposed by government legislative bodies. Their widespread application in a plethora of industries calls for an urgent need of the design and synthesis of their replacement. Recent research suggests that shortening of the fluorocarbon chain significantly lowers their environmental footprint. In this regard, we present the synthesis of a potentially non-bioaccumulative caroxyamide based cationic surfactants having fluorinated alkyl chain and their hydrocarbon analogue. They was characterized using 1 H, 13 C, and 19 F nuclear magnetic resonance spectroscopy (NMR) and Fourier transform infrared spectroscopy (FT-IR). The synthesized fluorosurfactant exhibits an excellent surface tension of less than 20 dyne cm^{-1} comparable to the legacy long chain ones at much lower critical micelle concentration, found using tensiometry and conductometry. The dynamic surface tension was determined and aggregation behaviour of the micelle was studied using dynamic light scattering. The comparative analysis of the properties of the fluorocarbon and hydrocarbon surfactants was also done.

Keywords: Fluorosurfactant, cationic, carboxyamide, non-bioaccumulative, surface activity

SYNTHESIS OF SHORT CHAIN THIOETHER CONTAINING NON-IONIC FLUOROSURFACTANT AND EVALUATION OF ITS SURFACE ACTIVITY

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Long-chain perfluorocarbon surfactants have been historically used in varied fields but restricted in production and application due to environmental concerns such as their bioaccumulation, non-degradation and high toxicity, making the development of new alternative surfactants an urgent need. Short chain fluorinated surfactants have emerged as promising alternatives to the conventional “long chain” perfluoroalkane sulfonates (PFOS) and perfluorocarboxylic acids (PFOA). Based on recent studies these alternatives have more favourable environmental and surface properties and, most notably, they have been found to be non-bioaccumulative. In this study, short chain amide based thioether containing non-ionic fluorinated surfactant has been synthesized along with its hydrocarbon analogue. The surface tension values of the synthesized fluorinated surfactant exhibits substantial reduction ranging from 15-20 mN/m using tensiometry method, comparable to that of legacy fluorinated surfactants. The structure of the synthesized molecules has been confirmed using ^{1}H, ^{13}C, ^{19}F NMR and Fourier Transform infrared spectroscopy (FT-IR). Additionally, the dynamic surface tension and aggregation behaviour of the synthesized fluorosurfactant have also been examined.

Keywords: Non-ionic fluorosurfactants, Surface tension, Synthesis, short chain

TECHNICAL SESSION IV

Invited Lectures

Chairperson: Prof. Boris A Noskov

16:00 – 16:30 **De-stabilization of oil-droplets adhering to practical solid surfaces with surfactant solutions**
Jaideep Chatterjee[1]

[1]Department of Chemical Engineering, BITS-Pilani, Hyderabad Campus, Telangana, India, 500078.

16:30 – 17: 00 **Directed chemical evolution of protein-based surfactants**
Prof. S Sandanaraj Britto

[1] Indian Institute of Science Education and Research (IISER) Pune

Oral Presentation

17:00 – 17:20 **Surfing the Green Wave: Bio Surfactants as Key Players in Environmental Restoration**
Dr. Veena Kumara Adi[1]

[1]Associated professor, Dept of Biotechnology, Bapuji Institute of Engineering and Technology, Davangere 577004, Karnataka, India

17:20 – 17:40 **Remediation of Pyrene contaminated red soil by nZVI (Nano Zero-valent Iron) and SiO_2 (Silica) nanoparticles stabilized Tween 80 (TW80) Surfactant foam**
Ipsita Priyadarshini[1], Chhavi Mishra[1], Arjun R. Shelar[1], Banasri Roy[1], Pradipta Chattopadhyay[1]

[1]Department of Chemical Engineering, Birla Institute of Technology and Science, Pilani-333031, Rajasthan, India

17:40 – 18:00 **Human serum albumin conjugated gold nanoparticles non-covalent interactions explored with antioxidants ferulic acid and sinapic acid**
Anjali[1], Nand Kishore[1]

[1]Department of Chemistry, Indian Institute of Technology Bombay, Powai, Mumbai –400076, India

DE-STABILIZATION OF OIL-DROPLETS ADHERING TO PRACTICAL SOLID SURFACES WITH SURFACTANT SOLUTIONS

Jaideep Chatterjee[1]*

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The use of aqueous surfactant solutions, in many applications, such as removal of oil trapped in underground reservoirs and cleaning of hard surfaces, is justified by the fact that surfactants in the aqueous phase can reduce the interface tension between oil and water, thereby facilitating its removal. However, some of the prevalent ideas, regarding the role of the surfactants, in causing the removal of oil from hard surfaces may need to be re- examined. In this paper, we look at experimental observations reported in the literature, on single oil-droplet sticking to irregular metallic solid surfaces, flooded with an aqueous surfactant solution. We use the Young-Laplace (YL) equation, which has been traditionally used to obtain the drop shape, based on the physical properties of the system, to the above system to estimate the IFT requirement for droplet removal. We show that YL equation with a unique set of boundary conditions can be use as a model to estimate the value of IFT that would be required to destabilize the above droplet, under practical conditions. In summary, the extent of IFT reduction required to physically destabilize adhering droplets, can be estimated based on the above method. We also look at the shape of small oil drops on hard surfaces flooded with surfactant solutions, and examine these drops as IFT is reduced from its original values and taken towards zero.

Keywords: IFT Reduction, Oil Removal, Oil recovery, Hard surface cleaning.

DIRECTED CHEMICAL EVOLUTION OF PROTEIN-BASED SURFACTANTS

Prof. S Sandanaraj Britto[1]

[1] Indian Institute of Science Education and Research (IISER) Pune

The vast diversity of proteins with spectacular structure and function results from natural evolution with a time scale of millions of years. With the invention of DNA recombinant technology, biologists exploited directed evolution principles to quickly create a vast number of self-assembling artificial proteins (SAPs). However, most of the SAPs made through genetic methods lack functions due to reasons they are restricted to the standard set of twenty amino acids. In this talk, I will discuss our laboratory efforts to design and synthesize SAPs with rich structural diversity through a directed chemical evolution method powered by a micelle-assisted protein labeling technology (MAPLabTech). The designer proteins self-assemble to form protein assemblies of defined size and shape and also exhibit exotic functions.

SURFING THE GREEN WAVE: BIO SURFACTANTS AS KEY PLAYERS IN ENVIRONMENTAL RESTORATION

Dr. Veena Kumara Adi[1]

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The contamination of soil by spent engine oil poses significant environmental challenges, impacting soil quality and ecosystem health. Soil, being a crucial component of natural ecosystems, plays a pivotal role in environmental sustainability. However, the presence of spent engine oil disrupts soil conditions, leading to poor aeration, nutrient immobilization, decreased water holding capacity, and pH variation. To address this issue, innovative technologies for soil contaminant removal have been pursued using novel, sustainable green molecule from microbe namely “Biosurfactant”. This study investigates the efficacy of biosurfactant in remediating spent engine oil contamination in soil. Various soil parameters including bulk density, pH, porosity, electrical conductivity, sieve analysis, and water holding capacity were analysed to assess the impact of biosurfactant on soil remediation. The findings underscore the effectiveness of biosurfactant as a promising tool for soil remediation, offering potential solutions to mitigate the adverse effects of spent engine oil contamination on soil ecosystems.

Keywords: biosurfactants, spent engine oil, spent wash, bioremediation, soil contamination.

REMEDIATION OF PYRENE CONTAMINATED RED SOIL BY NZVI (NANO ZERO-VALENT IRON) AND SIO_2 (SILICA) NANOPARTICLES STABILIZED TWEEN 80 (TW80) SURFACTANT FOAM

Ipsita Priyadarshini[1], Chhavi Mishra[1], Arjun R. Shelar[1], Banasri Roy[1], Pradipta Chattopadhyay[1]

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Various contaminants are present in soil but one of the major contaminants is Pyrene, a source of many health and environmental problems. The soil is being polluted by Pyrene though burning of wood, gasoline exhaust and plastics (industrial activities). The pyrene entering the soil disrupts the soil microbiome and the ground level water causing major health issues. To counter the issues caused by pyrene contamination, remediation through nZVI and SiO_2 nanoparticles stabilized Tween 80 (TW80) Surfactant foam can be done. This paper presents the remediation of Pyrene contaminated red soil using TW80 surfactant foam stabilized with nZVI and SiO_2 nanoparticles. Various characterizations of nanoparticles have been examined such as XRD, FESEM, FTIR, Raman and XPS. The foamability and foam stability of the various concentrations of TW80 Surfactant (2, 6, 12 mg/l) has been studied with and without nanoparticles (1, 3, 6 mg/l) to measure the better remediation efficacy. This remediation study exhibits significant promise for providing sustainable and economically viable treatment in environmental conservation.

Keywords- nZVI and SiO_2 nanoparticles, TW80 Surfactant Foam, Pyrene, Soil Remediation

HUMAN SERUM ALBUMIN CONJUGATED GOLD NANOPARTICLES NON-COVALENT INTERACTIONS EXPLORED WITH ANTIOXIDANTS FERULIC ACID AND SINAPIC ACID

Anjali[1], Nand Kishore[1]

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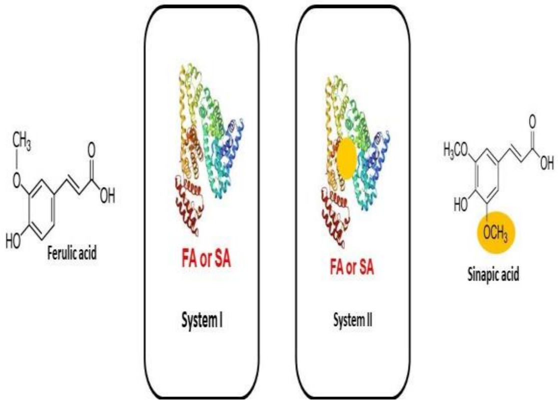
Recently, bioconjugated gold nanoparticles have been widely explored in research, health sectors and biomedical sciences. Due to their low toxicity and large surface area, Human Serum Albumin (HSA) conjugated gold nanoparticles (AuNPs) as nanocarriers for the delivery of drugs have been investigated. In this work their interactions with antioxidants hydroxycinnamic acids; ferulic acid (FA) and sinapic acid (SA) have been investigated. Size and morphology of HSA conjugated AuNPs were confirmed by Transmission Electron Microscopy (TEM) and Dynamic Light Scattering (DLS) measurements. Further, characterization of HSA_AuNPs has been done by UV-vis, fluorescence, circular dichroism (CD) and ATR-FTIR spectroscopies. FA and SA binding with HSA and HSA_AuNPs has been further analysed by using fluorescence quenching and Isothermal Titration Calorimetric (ITC) studies. Spectroscopic data has been interpreted in correlation with the thermodynamic signatures obtained from ITC experiments. With only HSA, both FA and SA show single binding site on the protein. Whereas, HSA conjugated AuNPs show multiple binding sites for FA and SA. FA shows stronger binding with HSA as compared to SA whereas SA exhibits higher binding with HSA_AuNPs. The binding of these hydroxicinnamic acids depends on the structure of protein as well as the functionality of the HCAs. Minor change in conformation of HSA upon coating on gold nanoparticles is observed to improve the drug binding. Such studies are important in identifying the nature of interactions and functional groups which are responsible for binding the protein and development of suitable drug delivery systems.



Keywords: Hydroxycinnamic acids; bioconjugation; binding site; isothermal titration calorimetry.

PLENARY LECTURE 2

Chairperson: Prof. Srinivas Krishnaswamy

POLYMERIZED IONIC LIQUID SURFACTANTS FOR ADVANCED MATERIALS

John Texter[1]

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Surface active imidazolium acrylates, a subclass of ionic liquids, have been developed as building blocks for polymerized ionic liquids, PIL (nanolatexes, block copolymers, random copolymers, homopolymers), that exhibit reversible and irreversible stimuli-responsive phase phenomena. These surface-active polymers have established a new branch of materials science, and some of these new PIL materials are finding innovative applications as thermodynamically stable nanoparticulate dispersions and as dispersing aids with tunable solubilities. We discuss PIL examples synthesized by radical chain-polymerization and by condensation step-growth polymerization.

These PIL are illustrated to be excellent stabilizers for SWCNT (single-wall carbon nanotubes), MWCNT (multiwall carbon nanotubes), hydrothermal carbon, and graphene in water. SEM (scanning electron microscopy) illustrates that imidazolium-based PIL nanolatexes bind randomly and reversibly from suspension onto nanocarbon surfaces. Excellent aqueous dispersion stabilization is provided by strong binding to sp^2-nanocarbon surfaces via $\prod$-overlap and by solvation of imidazolium bromide by water. These strong binding and osmotic-brush effects have provided means to prepare the most concentrated aqueous dispersions of nanocarbons (MWCNT,17% w/w; graphene, 6.4% w/w) reported to date generated by liquid-phase exfoliation in water.

Sedimentation and shear-coating produce MWCNT and graphene electrodes suitable for conventional and advanced material applications. Aqueous PIL-stabilized nanocarbon dispersions are phase-transferable and stimuli-responsive. They facilitate making thermally conductive hydrothermal carbon coatings (25 W/m/K); thermally conductive MWCNT coatings in the diamond range (0.5 - 3 kW/m/K); graphene rheo-optical dispersions exhibiting amorphous-nematic transitions induced by Couette-shear; alternative coating methods derived from the stimuli-responsiveness of imidazolium-anion exchange; and transformational electrode heterostructures produced by electrospinning.

Keywords: dispersion stability, ionic liquids, nanolatex, polymerizable surfactants, polymerized ionic liquids, thermodynamic stability

TECHNICAL SESSION V

Invited Lectures

Chairperson: Prof. Kallol K. Ghosh

10:00 – 10:30	**To be announced** Prof. Jingcheng Hao

Oral Presentation

10:30 – 10:50 **From Self-Assembly to Drug Delivery: Understanding and Engineering Protein Fibrils by pluronics monomers and micelles**

Anu Jain[1,*], and Nand Kishore[1]

[1]Department of Chemistry, Indian Institute of Technology Bombay, Powai, Mumbai – 400076, India

FROM SELF-ASSEMBLY TO DRUG DELIVERY: UNDERSTANDING AND ENGINEERING PROTEIN FIBRILS BY PLURONICS MONOMERS AND MICELLES

Anu Jain[1,*], and Nand Kishore[1]

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Understanding misfolding and aggregation of proteins is important in disciplines of proteins, pharmaceuticals, and biomedical fields. This work examines lysozyme fibrillation in the presence of pluronics (F68 and F127) using combination of calorimetry and spectroscopy. Pluronic copolymers self-assemble to form polymeric micelles, or micellar-type nanostructures in aqueous solution, at concentrations higher than critical micellar concentration. The results obtained from isothermal titration calorimetry suggest that interaction of protein with F68 is exothermic while with F127 it is endothermic due to more hydrophobicity of the latter. TEM images and ThT assay demonstrated that pluronics promote fibrillation rather than inhibition. The pre- and post-micellar concentrations of pluronics on interaction with protein (at different fibrillation stages) exhibit a reduction in ΔHmo as the incubation time increases. Consequently, the potential use of these formed aggregates for drug delivery was explored using anticancer drugs (5-fluorouracil and cytarabine). When cytarabine is used with protein fibrils, the hydrophobic interaction predominates, according to endothermic enthalpy of interaction, but the electrostatic interaction predominates with 5-flourouracil. On the other hand, the former drug exhibited more adsorption on the surface of protein fibrils compared to the latter. Therefore, it is concluded that cytarabine has weak adsorption on fibril surfaces and is readily desorbed in cells, whereas 5-fluorouracil has relatively strong adsorption; as a result, the complex of LFF127 and 5-FU is fatal to malignant cells. These results are beneficial for exploring numerous applications of the formed protein fibrils/aggregates and in providing suitable strategies for the design and development of drug delivery agents.

Keywords: Protein Fibrillation; Pluronics; Calorimetry; Spectroscopy; Adsorption

TECHNICAL SESSION VI

Invited Lectures

Chairperson: Prof. Vivek Rangarajan

10:00 – 10:30 **Surfactant crystals at gas/liquid interfaces for foam stability**
Prof. Anniina Salonen[1]

[1]Laboratoire de Physique des Solides, Université Paris-Saclay, Orsay, France.

Oral Presentation

10:30 – 10:50 **Unravelling Thermodynamics signatures accompanying binding of protein to lipid nanoparticles: A calorimetric and spectroscopic analysis**
Jyoti Rathee[1], Nand Kishore[1]

[1]Department of Chemistry, Indian Institute of Technology Bombay, Powai, Mumbai, India

SURFACTANT CRYSTALS AT GAS/LIQUID INTERFACES FOR FOAM STABILITY

Anniina Salonen[1]

[1]Laboratoire de Physique des Solides, Université Paris-Saclay, Orsay, France.

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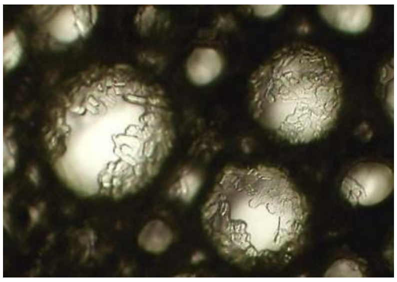
Surfactants are extremely versatile molecules, and their ability to assemble into a wide variety of structures and to adsorb onto interfaces is the key of their success. The adsorption onto surfaces also gives them the ability to stabilise foam. Indeed, surfactant foams are used in food products, for cleaning purposes, to extract petrol and in many other industrial processes and products. This makes the control of the foam properties and stability such important questions.

Often surfactant foams are rather unstable, and disappear in a few hours. An efficient way to control the properties of surfactant-lades interfaces and solutions is to add salt or co-surfactants. The changing solution properties can change foam stability drastically. I will show how the foam stability is influenced by the changing bulk self-assembly, through precipitating surfactant with the addition of salt (as shown in the Figure on the right). These particles can be excellent foam stabilisers, leading to extremely stable foams in which all the ageing processes are stopped. However, as the structures melt at higher temperatures, the foams are also stimulable.



The use of surfactant assemblies in foams allows for fine control of the foam stability and properties.

Keywords: precipitation, foam, gas/liquid interface

UNRAVELLING THERMODYNAMICS SIGNATURES ACCOMPANYING BINDING OF PROTEIN TO LIPID NANOPARTICLES: A CALORIMETRIC AND SPECTROSCOPIC ANALYSIS

Jyoti Rathee[1], Nand Kishore[1]

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With the booming development of nano-medicines, significant attention has been paid to biocompatible solid lipid nanoparticles (SLNs) owing to their desired nano-assembly properties such as long-term stability, and higher encapsulation efficiency. When the lipid nanoparticles are administrated in in-vivo, their bio-distribution, and cellular internalization are significantly affected by the diversified biological fluids having different pH and abundant biomolecules. Therefore, the study of the binding interactions of the SLNs with the serum albumins will pave the way to understanding the bimolecular recognition process essential for the rational drug design process. The current investigation delineates the quantitative analysis of the thermodynamic signatures associated with the interactions of Bovine Serum Albumin (BSA) with lipid nanoparticles using a combination of calorimetric and spectroscopic techniques. It was revealed from the fluorescence spectroscopy that SLNs bind to the BSA protein significantly and the nature of their binding was examined. Furthermore, Differential Scanning Calorimetry (DSC) experiments demonstrated the stability profile of the protein in the presence of the SLNs. Later on, protein conformational stability was studied by employing Circular Dichroism (CD) Spectroscopy. Thermodynamics studies using Isothermal Titration Calorimetry (ITC) provided the binding affinity of the BSA with SLNs in terms of enthalpy change (ΔH), entropy change (ΔS), and free energy change (ΔG). Obtained results demonstrated significantly good affinity of SLNs with BSA which facilitates their easy transportation to desired targeted sites.

Keywords: Lipid nanoparticles, BSA, Calorimetry, Interactions

TECHNICAL SESSION VII

Invited Lectures

Chairperson: Prof. Soumen Ghosh

11:20 – 11:50

Design and development of novel Micellar catalytic systems for Organophosphate toxicants

Kallol Ghosh[1]

[1]School of Studies in Chemistry, Pt. Ravishankar Shukla University, Raipur-492010, Chhattisgarh, India

11:50 – 12:10

Probing Surfactant Interactions with Different Interfaces: Case Studies with Nanochitin and Fibrous Nonwoven Fabrics

Prottasha Sarker[1], Pallav Jani[1], Anicah Smith O'Brien[1], Orlando J. Rojas[2] & Saad A. Khan[1]

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[2]Bioproducts Institute, Department of Chemical & Biological Engineering, The University of British Columbia, Vancouver, British Columbia V6T 1Z3, Canada

Oral Presentation

12:10 – 12:30

Insight into Surfactant-assisted Enhanced Oil Recovery: Spectroscopic Approach for Understanding Oil Solubilization for Designing Effective Injection Fluid

Uttam K. Bhui[1] & Rincy Anto[2]

[1]Department of Petroleum Engineering, School of Energy Technology, Pandit Deendayal Energy University, Raisan, Gandhinagar, Gujarat 382426, India
[2]Global Sustainable Eco-Solutions, 722 Sharan Circle Hub, Zundal Circle, Zundal, Gandhinagar, Gujarat, 382421, India

12:30 – 12:50

Outstanding stability and enhanced activity of Cytochrome-c induced by surfactant in aqueous mixtures of deep eutectic solvent

Omish Sethi[1], Tejwant Singh Kang[1,*], Ashwani Kumar Sood[1,*]

[1]Department of Chemistry, UGC Centre for Advance Studies-II, Guru Nanak Dev University, Amritsar, Punjab, India

DESIGN AND DEVELOPMENT OF NOVEL MICELLAR CATALYTIC SYSTEMS FOR ORGANOPHOSPHATE TOXICANTS

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For the last many years we have been developing novel micellar catalysts as nanoreactors for the organophoshate pesticides and chemical warfare agents in collaboration with several leading scientists. Different strategies have been formulated using functionalized green surfactants for acyl transfer reactions. The functionalized surfactants with pyridinium/imidazolium core in their head groups and α-nucleophilic moiety viz. oximate/hydroxamate/amidoximate groups have been explored. More recently, the focus has shifted to surface active ionic liquids (SAIL) with special bias on amino acid based micellar system. In this presentation, the important trends, review of the earlier work, recent development and novel strategies for the kinetic efficiency of some micellar systems toward the hydrolysis of carboxylic and phosphate esters will be presented. The physicochemical and surface properties of single and mixed system of functionalized surfactants will also be discussed. Finally, the current challenges and opportunities as well as future development will be discussed.

PROBING SURFACTANT INTERACTIONS WITH DIFFERENT INTERFACES: CASE STUDIES WITH NANOCHITIN AND FIBROUS NONWOVEN FABRICS

Prottasha Sarker[1], Pallav Jani[1], Anicah Smith O'Brien[1], Orlando J. Rojas[2] & Saad A. Khan[1]

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Chitin nanocrystals (ChNC), derived from chitin found in natural sources such as crustaceans, fungi, and insects, have emerged as relevant bio-based colloids. The first part of the talk will examine the interactions of ChNC with surfactants sharing the same hydrophobic tail (C12) but different head groups: dodecyl sulfate (SDS), dodecyltrimethylammonium bromide (DTAB), and polyoxyethylene(23)lauryl ether (Brij-35). Isothermal Titration Calorimetry (ITC) which probes molecular interactions, reveals that cationic DTAB has minimal interaction with ChNC, nonionic Brij-25 exhibits moderate interactions at low concentrations, while SDS shows strong interactions that fall across four distinct regimes with SDS addition. Such behavior is initiated through electrostatic attraction and evolves into surfactant micelle formation on ChNC surfaces. Dynamic rheological elastic modulus (G') also shows nonlinear variation upon SDS addition, mirroring that observed in ITC experiments. This direct correlation provides insight into creating nanocomposites with tailored properties. The second part of the talk focuses on polypropylene (PP)-based fibrous nonwovens, used in hygiene products, where a small-molecule slip additive, erucamide, migrates to the surface. The interactions between erucamide and hydrophilic surfactants dictate the wetting and soft feel of the fabrics. Using Quartz Crystal Microbalance (QCM-D), contact angle, and adsorption measurements, we discuss how high (Tween 20, Tween 80) and low HLB surfactants (Span 20, commercial) affect adsorption and wettability of the pristine and erucamide-bloomed PP surfaces. For example, strongest adsorption and prolonged wettability is observed with low HLB surfactant-erucamide system, likely due to weakly exothermic and thermodynamically favorable interactions. Such insights can be utilized to develop tailored surfaces.

Keywords: ITC, rheology, QCM-D, nanochitin, erucamide

INSIGHT INTO SURFACTANT-ASSISTED ENHANCED OIL RECOVERY: SPECTROSCOPIC APPROACH FOR UNDERSTANDING OIL SOLUBILIZATION FOR DESIGNING EFFECTIVE INJECTION FLUID

Uttam K. Bhui[1] & Rincy Anto[2]

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For meeting the futuristic energy demand, various enhanced oil recovery (EOR) methods have been adopted for the optimization of production from subsurface petroleum reservoirs, where chemical methods particularly surfactant-assisted EOR methods are gaining importance for wide range of crude oil reservoirs. Surfactant assisted injection fluids reduces the interfacial tension of the oil-water-surfactant system forming micelle structures by entrapping the components of crude oil in their micellar microenvironment. Thus, the nature and composition of crude oil, type of surfactant, pH and salinity plays an important role for understanding the efficacy of the injected fluid for EOR.

This study demonstrates the molecular level interaction mechanism of oil solubilization inside the micellar microenvironment through optical spectroscopic approach for designing effective injection fluids. For this purpose, aqueous surfactant solutions of different charges and crude oil of different types have been selected and studied under different physiochemical conditions. The steady-state fluorescence measurements at varying excitation wavelengths, of the oil components entrapped within the micelles of different charges, show different emission peaks implying the selective solubilization of polycyclic aromatic hydrocarbons (PAH) compounds with varying fused aromatic rings (FAR). pH and salinity variation also play an important role in oil solubilization. The fluorescence property of the aqueous surfactant solution and crude oil mixture in the present study provides valuable insights into the critical factors governing the micellar entrapment mechanisms and examines the oil solubilization efficacy, which can assist in designing effective surfactant-assisted EOR fluids for maximizing oil recovery from subsurface reservoirs.

Keywords: Polycyclic Aromatic Hydrocarbon (PAH), Fused aromatic ring (FAR), Surfactant, Enhanced oil recovery (EOR), Micelle.

OUTSTANDING STABILITY AND ENHANCED ACTIVITY OF CYTOCHROME-C INDUCED BY SURFACTANT IN AQUEOUS MIXTURES OF DEEP EUTECTIC SOLVENT

Omish Sethi[1], Tejwant Singh Kang[1,]*, Ashwani Kumar Sood[1,]*

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Deep eutectic solvents (DESs), despite having a lower cohesive energy density as compared to water, have been established as alternate solvent media for the self-assembly of surfactants, thanks to the ionic milieu and other driving forces operating therein. The nanoclustering of DES at low water content and its complete de-structuring at high water content affect the self-assembly in a contrasting manner, governed by different sets of interactions and hence the activity of Cytochrome-c (Cyt-c). Investigations using surface tension, fluorescence, dynamic light scattering (DLS), and isothermal titration calorimetry (ITC) have shown that DES-water mixtures highly promote the aggregation of sodium N-lauroyl sarcosinate (SLS), resulting in the lower critical aggregation concentration (~2–6-fold) of the surfactant as compared to water. The water-DES mixtures having colloidal self-assembled structures of SLS were examined as suitable media for peroxidase activity of Cyt-c, which showed enhanced enzymatic activity. Cyt-c dispersed in DES-water colloidal solutions demonstrated 5-fold higher peroxidase activity than that observed in phosphate buffer. Further, it is expected that the present work will offer a new perspective on designing and controlling the properties of self-assembled structures in aqueous mixtures of DESs for various applications.

Keywords: Biocatalysis, Deep eutectic solvents, Surfactants in Solutions, Self-assembly, Sustainable Chemistry

TECHNICAL SESSION VIII

Invited Lectures

Chairperson: Prof. Saroj Baral

11:20 -11:50 **Lessons learned from modelling surfactants at multiple scales: reverse micelles, emulsions and adsorption**
Maria Sammalkorpi[1]

[1]Aalto University, Finland

Oral Presentation

11:50 – 12:10 **Interfacial phenomena in leaching of critical metals from spent lithium-ion battery cathode**
Madhusmita Dash [1,2], Himansu Sekhar Nanda [2*], Soobhankar Pati[1]

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12:10 – 12:30 **How Zwitterionic Surfactants Affects the Photophysics of Styryl Dye in Triblock Copolymer Assembly with Different PEO and PPO Composition?**
Sapana Sinha[1], Sagar Srivastava[1], Debabrata Seth[1,*]

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12:30 – 12:50 **Phototriggered Drug delivery system of Di-block copolymeric and Spiropyran micelles via NSET mechanism for targeted and real-time drug delivery**
Shalini Dyagala[1], Subit K Saha[1*]

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LESSONS LEARNED FROM MODELLING SURFACTANTS AT MULTIPLE SCALES: REVERSE MICELLES, EMULSIONS, AND ADSORPTION

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Surfactants self-assemble in solvents and at interfaces to a variety of morphologies because of their amphiphilic nature. The variables controlling the self-assembly response include not only the molecular species, the solvent, species concentrations, but the thermodynamic conditions, and when present, also external driving forces. Fascinating emergent structure formation and dynamically changing properties to the response rise, when the assembly is biased by external driving, e.g., by gradients or external fields.

Computer simulations offer an interesting tool to extract the assembly dependencies on individual system variables. However, a challenge for modelling is that the surfactant self-assembly takes place both at molecular level and at aggregate assembly level, which correspond to different time and length scales in modelling approaches. Notably, in contrast to aqueous solutions, the self-assembly of amphiphilic surfactants in organic, apolar solvents remains relatively poorly understood at the level of mechanisms and control factors. We have used computer modelling approaches that range from atomistic detail to particle-based mesoscale modelling and thermodynamic models, in equilibrium and with external driving. I discuss here our recent findings, focusing especially on apolar solvent assembly response, molecular level control means for the response via the surfactant species but also additives and the effect of thermodynamic variables. I compare the findings with experimental data and discuss the significance for guiding engineering of advanced surfactant-based materials.

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INTERFACIAL PHENOMENA IN LEACHING OF CRITICAL METALS FROM SPENT LITHIUM-ION BATTERY CATHODE

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The explosive increase in the use of Lithium-ion batteries (LiBs) necessitates their effective and efficient recycling to tackle the shortage of resources and environmental pollution. An efficient recovery of critical metals such as lithium (Li), cobalt (Co), nickel (Ni) present in spent LIBs is currently the most promising measure to achieve environmental and economic benefits. With the aim to make the leaching processes sustainable, it is necessary to explore the use of green solvents. Deep eutectic solvents (DESs) are green solvents with great potential in recovering valuable metal elements from spent LIBs. This environmentally friendly practices could reduce waste, energy usage, and greenhouse gas emissions, as well as preserving raw materials. Here, the present work focuses on the dissolution of mixture of cathode materials of spent LIB in an ethylene glycol (EG): choline chloride (ChCl) based DES. The effect of different parameters on leaching of Li, Co and Ni were systematically investigated. The experimental results showed that the leaching efficiencies of Li, Co and Ni can reach 95.5%, 69.9%, 71.5% respectively, under the optimal conditions: (i) a reaction temperature of 180 °C, (ii) ChCl: EG with a molar ratio of 2:1 and (iv) a reaction time of 24 h. Furthermore, the leaching efficiencies were substantially higher when the mixture was exposed to aqua regia vapor, and HCl vapor as compared to HNO_3. This result ensures that the Cl^- ion has significant contribution for higher leaching efficiencies.

Key words: Spent Lithium-ion battery recycling; critical metals; Deep eutectic-solvents; leaching.

HOW ZWITTERIONIC SURFACTANTS AFFECTS THE PHOTOPHYSICS OF STYRYL DYE IN TRIBLOCK COPOLYMER ASSEMBLY WITH DIFFERENT PEO AND PPO COMPOSITION?

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Fundamental investigations into the physical behaviours of pluronic-surfactant mixed assemblies are essential to advance our understanding of molecular interactions at the nanoscale, setting the stage for innovative solutions in drug delivery, diagnostics and other applications of pluronic-surfactant assemblies. While numerous studies have explored the interaction between pluronics and charged surfactants, the realm of research focusing on the integration of pluronics with zwitterionic surfactants—compounds characterized by their simultaneous possession of positive and negative charges—remains scarce. This investigation explores the intricate photophysics of pluronic-zwitterionic surfactant mixed assemblies, utilizing the twisted intramolecular charge transfer (TICT) active styryl dye, trans-2-[(4-dimethylamino) styryl] benzothiazole, as a probe to discern the effects of polarity changes within the assembly microenvironment[1]. By comparing the behaviours of two distinct pluronics at concentrations of 5wt% and 10wt%, F108 and F127 each, which differ in their polyethylene oxide (PEO) and polypropylene oxide (PPO) unit composition, this study systematically examines the impact of zwitterionic surfactants, SB3-12 [Dodecyl dimethyl(3-sulfopropyl) ammonium hydroxide inner salt] and SB3-14 [3-(Myristyldimethylammonio) propanesulfonate]. Through a comprehensive set of spectroscopic techniques, including UV-visible absorption, steady-state emission, time-resolved fluorescence emission studies, significant alterations in the emission spectra and quantum yield were observed upon zwitterionic surfactant addition with multi-exponential emission decay. These modifications suggest a dynamic equilibrium of dye molecules transitioning between various microenvironments within the assemblies, highlighting the interplay between surfactant concentration and the physicochemical properties of pluronic-surfactant systems. Additionally, dynamic light scattering (DLS), Zeta Potential and fluorescence lifetime imaging microscopic (FLIM) analyses shed light on the altered hydrodynamic size, charge defining interaction, and in-situ shapes, of the assembly respectively, revealing the substantial impact of surfactant incorporation on the structural and photophysical properties of the assemblies. This research underscores the potential of zwitterionic surfactants to modulate the microenvironmental properties of pluronic-based systems, offering promising avenues for enhancing the applications of such assemblies.

Key words: pluronics, zwitterionic surfactants, TICT, styryl dye, DLS

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PHOTOTRIGGERED DRUG DELIVERY SYSTEM OF DI-BLOCK CO-POLYMERIC AND SPIROPYRAN MICELLES VIA NSET MECHANISM FOR TARGETED AND REAL-TIME DRUG DELIVERY

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A light-responsive drug delivery system based on polymeric micelles has been formulated, utilizing readily available and cost-effective materials such as an amphiphilic di-block copolymer, mPEG-PLA, and a Spiropyran derivative. For real-time monitoring of drug release, the system is embedded with gold nanoparticles (AuNPs) via in-situ synthesis. The fluorescence is OFF before the cancer drug doxorubicin (DOX) delivery as the Nanomaterial Surface Energy Transfer (NSET) from the drug to AuNPs is ON. However, the fluorescence is ON once the drug is delivered as the NSET mechanism is OFF. This system, thus, addresses the major challenges in drug delivery systems, i.e., real-time monitoring of drug release, targeted drug delivery, and on-demand drug release. Photochromism and size switching were characterized using UV-Vis spectroscopic and dynamic light scattering (DLS) techniques, respectively. Morphologies of pure micelles and micelles loaded with DOX and AuNPs have been analyzed using images obtained from Field emission scanning electron microscopy. Energy transfer processes during in-situ synthesis of AuNPs and drug release after light (365 nm)-induced size-switching of nanocarrier have been demonstrated by steady-state and time-resolved fluorescence and fluorescence anisotropy of DOX. These data have been utilized to calculate the energy transfer parameters. The DOX-mPEG PLA-Spiropyran formulation exhibited an encapsulation efficiency of ~73.16% and a DOX-loading of around 6.45%. DOX- mPEG PLA-Spiropyran micelles (1:3:1) were stable as proven by a kinetic stability study. Moreover, they showcased the sustained release of encapsulated DOX for over 60 hours, as validated by In vitro drug release studies. Cell internalization, intracellular photo-triggered drug release, and fluorescence cell imaging in murine melanoma (B16F10) and human oral squamous cell carcinoma (FaDu-HTB-43) cells have been investigated. Studies confirmed photo-triggered drug delivery within living cells and the NSET effect. Cell viability was assessed through MTT assays, evaluating the cytotoxicity of the micellar system on B16F10, and FaDu-HTB-43 cells. Overall, this study demonstrates the efficacy of this drug delivery system for cancer treatment, enabling on-demand photo-triggered drug release, real-time monitoring, and deep penetration into tumors to enhance therapeutic effects.

Keywords: mPEG-PLA, In-situ synthesis, Au nanoparticles, DOX, photochromism

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PLENARY LECTURE 3

Chairperson: Dr. Hrushikesh Mirgal

INTERNALLY NETWORKED NANOGELS

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Nanogels of cross-linked polymers are hydrophilic nanoparticles internally networked within finite dimensions (i.e., <100 nm). The networks have a tendency to imbibe water when placed in an aqueous environment, and can be synthesized by cross-linking the polyion and nonionic polymers or polymeric self-assembled hydrogels. Nanogels have the nanoscale size and narrow distribution which can lead a delivery of oligonucleotides into the brain and a rapid response to the biological pH conditions.

We synthesized poly(amino acid)s based amphiphilic graft copolymers, attracting increasing attention due to their biocompatibility, biodegradability, and multi-functionality originating from multiple branches of many different characteristic polymers or inorganic nanoparticles. Amphiphilic poly(amino acid)s graft polymers have been prepared by 'graft onto' or 'graft from' methods, and the morphologies of their self-aggregates can be controlled by adjusting the chemical nature of the polymers. On the basis of the resultant multifunctionality, versatile poly(amino acid)s based graft polymer systems have demonstrated improved drug delivery and diagnosis.

In this talk, presented will be covered diverse morphologies of self-assembled nanostructues prepared from amphiphilic poly(amino acid)s, and stable self-aggregates were obtained from internal cross-linking of micelles. Further, nanogels, hydrogel nanoparticles, can be prepared by conversion of hydrophobic core to hydrophilic core of the cross-linked micelles with pH sensitive change and release. Biocompatible and biodegradable poly(amino acid)s based nanostructures have a great potential for biomedical applications such as drug delivery carriers and MRI contrast agents.

Keywords: nanogel, amphiphilic graft copolymer, poly(aminoacid), drug delivery

Acknowledgments

This research has been supported by Korea National Research Foundation and also many thanks to my former students.

TECHNICAL SESSION IX

Invited Lectures

Chairperson: Dr. Venkataraghavan

10:00 – 10:30 **Effect of non-ionic surfactants on the wetting property of cationic surfactant**

Samiran Mahapatra[1,*], Shanthi Appavoo[1], Vivek Kumar[2], Tulika Bhattachaya[2], Shweta Sharma[2] and Yogesh M Joshi[2,*]

[1]Unilever R&D Bangalore, 64 Main Road, Whitefield, Bangalore 560066, India
[2]Department of Chemical Engineering, Indian Institute of Technology, Kanpur 208016, India

Oral Presentation

10:30 – 10:50 **Biosurfactant production using waste engine oil degrading bacteria pseudomonas aeruginosa gi KP163922: A promising solution for dye removal using nano-adsorbents**

Mohan Jujaru[1], Ayan Bera[1] and Amit Jain[1*]

[1]Department of Chemical Engineering, Birla Institute of Technology and Science, Pilani, Pilani-333031, Rajasthan, India

EFFECT OF NON-IONIC SURFACTANTS ON THE WETTING PROPERTY OF CATIONIC SURFACTANT

Samiran Mahapatra[1,*], Shanthi Appavoo[1], Vivek Kumar[2], Tulika Bhattachaya[2], Shweta Sharma[2] and Yogesh M Joshi[2,*]

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Binary mixtures of surfactants exhibit fascinating behavior based on the intermolecular interactions between different surfactant classes. This study explores explicitly how adding non-ionic surfactants (alkyl polyglucoside (APG215), and fatty alcohol ethoxylate (EO7)) affects the wetting properties of a cationic surfactant benzalkonium chloride (BKC) on steel plates using the dynamic contact angle method. We observed a significant decrease in contact angle and enhanced wetting upon incorporating non-ionic surfactants into the BKC system. Interestingly, APG215 addition proved to be more effective than EO7 in promoting wetting properties of BKC. To understand the difference in synergestic behaviour, proton NMR spectroscopy analysis was carried out on individual and mixed surfactant systems. The NMR analysis revealed that the comparable size of BKC and APG215 molecules facilitates efficient mixed micelle formation, which enhances its effectiveness. Conversely, the long and flexible head group of EO7 affects the packing of monmers thereby hindering optimal mixed micelle formation, resulting in a less pronounced wetting effect.

BIOSURFACTANT PRODUCTION USING WASTE ENGINE OIL DEGRADING BACTERIA PSEUDOMONAS AERUGINOSA GI |KP163922|: A PROMISING SOLUTION FOR DYE REMOVAL USING NANO-ADSORBENTS

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In recent times, biosurfactants have garnered considerable interest owing to their favorable attributes, including low toxicity, biodegradability, and eco-friendly nature. Nevertheless, despite these merits, their competitiveness with chemical surfactants is hindered by the substantial costs associated with their production and substrates. Addressing this problem requires the strategic use of inexpensive substrates, which can constitute a significant portion (30-40%) of the total production expenses, thereby substantially reducing the overall production costs of biosurfactants. The current research focuses on the synthesis of rhamnolipid biosurfactant by a strain of Pseudomonas aeruginosa, which degrades hydrocarbons and simultaneously produces biosurfactants. An experiment was carried out in batch scale to evaluate the degradation of waste engine oil by this strain, with glucose serving as a co-substrate. Analysis using Gas Chromatography-Mass Spectrometry (GC-MS) showed that the strain could degrade various compounds and benzene derivatives. FTIR and 1H NMR confirmed that the biosurfactant produced was rhamnolipid. TGA and DSC studies were conducted to examine the thermostability and degradation pattern of the biosurfactant. The rhamnolipid exhibited emulsifying activity against a range of hydrocarbons (palm oil, sunflower oil, waste engine oil, and dodecane) respectively. For the application part: The synthesized rhamnolipid and bimetallic nanoparticles were incorporated into the biochar for the removal of cationic dyes from the simulated industrial water.

Keywords: Biosurfactant, Bimetallic nanoparticles, Emulsifying activity, Glucose, Pseudomonas aeruginosa, Waste engine oil.

TECHNICAL SESSION X

Invited Lectures

Chairperson: Prof. Konrad Terpilowski

10:00 – 10:30 **Dynamic surface properties of protein aggregates**

B.A. Noskov[1], A.V. Akentiev[1], A.G. Bykov[1], N.A. Isakov[1], O.Y. Milyaeva[1]

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Oral Presentation

10:30 – 10:50 **Innovation of sustainable surfactants: BASF Perspective**

Rohini Gupta[1*], Ashish Taneja[2], Stefan Hirsemann[2], Juergen Tropsch[3], Kati Schmidt[3], Thomas Greindl[3]

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DYNAMIC SURFACE PROPERTIES OF PROTEIN AGGREGATES

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The surface activity of protein aggregates can exceed the activity of native proteins. Although the aggregates proved to be effective stabilizers of foams and emulsions, information on the surface properties of their aqueous dispersions has been scarce until the last years. Application of the dilational surface rheology together with optical methods and atomic force microscopy allowed investigation of the morphology and properties of adsorbed and spread layers of protein aggregates at the liquid – gas interface [1-4]. The high dynamic surface elasticity was discovered for the most of the systems. Another important distinction between the properties of the layers of protein aggregates and the layers of native proteins consists in different mechanisms of the layer collapse. A short review of recent studies of the dynamic and static properties of the layers of protein aggregates at the liquid – gas interface will be given with special attention to the properties of the layers of amyloid fibrils and protein microgels.

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INNOVATION OF SUSTAINABLE SURFACTANTS: BASF PERSPECTIVE

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Innovation trajectory of surfactants has been rooted in sustainability from the inception. Workhorse surfactants that determine the performance of care chemicals must undergo regulatory and consumer scrutiny. BASF is taking a holistic approach to achieve sustainable surfactants and meet our Environmental, Social, and Governance (ESG) goals, via responsible procurement, climate protection and sustainable product portfolio. For example, BASF has RSPO-certified products at 25 locations worldwide for cosmetic, detergent, and cleaning agent industries as of 2020. BASF is pursuing 5 pathways toward more sustainable surfactants: (1) Building blocks from 2nd generation bio-refineries, (2) Known building blocks but more sustainable carbon sources, (3) Fermentation to new surfactants, (4) Process optimization, and (5) System solutions. In this presentation, we will expand on each of these pathways to underscore the importance of this holistic approach, which encompasses the spectrum of new materials to product lifecycle management to environmental footprint as BASF leads the future of clean. Lastly, we will highlight the in-house tools and capabilities that empower innovation of sustainable surfactants at BASF, namely high throughput screening, coarse model development and molecular modeling using our supercomputer, “Quriosity”.

Keywords: surfactants, innovation, sustainability, digitalization, BASF

TECHNICAL SESSION XI

Invited Lectures

Chairperson: Dr. Samiran Mahapatra

11:20 -11:50 **Sustainable surfactants: The role for feedstocks, technologies and new chemistries**

Dr. Venkataraghavan R[1]

[1]Unilever R&D Bangalore, 64, Main Road, Whitefield, Bangalore 560066

11:50 – 12:10 **Baroplastics: A Deep-Sea-Inspired Path to Sustainable Polymers**

Prof. Shigeru Deguchi[1]

[1]Japan Agency for Marine-Earth Science and Technology (JAMSTEC), 2Kyoto Institute of Technology, 3Kyoto University

Oral Presentation

12:10 – 12:30 **Surface, interfacial and thermodynamic aspects of the biosurfactant-salt systems**

Lalit M. Pandey[1,2*], Anurag Mishra[2], Pankaj Tiwari[2,3]

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[3]Department of Chemical Engineering, Indian Institute of Technology Guwahati, Guwahati, Assam, 781039, India

12:30 – 12:50 **Exploring the influence of surfactant collector bath characteristics on the morphology of electrospun polystyrene magnetite composite fibers**

Aakanksha Mohan[1], Sutapa Roy Ramanan[1,*]

[1]Department of Chemical engineering, BITS Pilani K K Birla Goa Campus, India

SUSTAINABLE SURFACTANTS: THE ROLE FOR FEEDSTOCKS, TECHNOLOGIES AND NEW CHEMISTRIES

Prof. Dr. Venkataraghavan R[1,*]

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Surfactants, by virtue of enabling emulsions, foams, and micelles, have a wide range of applications across different industries, such as detergents, personal care, food, oil, pharmaceuticals, and agriculture. They enhance the cleaning, wetting, dispersing, solubilizing, foaming, and anti-foaming properties of various products, as well as modify their rheology, viscosity, and stability, thus improving the performance, quality, and functionality. As with other chemicals and their impact on sustainability, there has also been a renewed focus on looking at sustainable surfactants. In this context, the reliance on fossil resources, dependence on palm causing deforestation and social issues, as well as the high GHG footprint associated with production and post-use persistence or biodegradation in the natural environment are matters of concern. This provides an opportunity to research enhancing functionality of surfactants, while reducing environmental impact, assessing the role for ingredients, feedstocks, technologies, and new chemistries. This with embracing the exciting advances in low-carbon chemistry, using renewable or recycled carbon sources and end our dependence on non-replaceable fossil carbon. In this talk, I will present the scientific possibilities and examine future feedstocks and technologies for sustainable surfactants, along with the need for new chemistries that may be inherently more effective and sustainable.

Keywords: sustainability, sustainable surfactants, feedstocks, conversion technologies, new chemistries

BAROPLASTICS: A DEEP-SEA-INSPIRED PATH TO SUSTAINABLE POLYMERS

Shigeru Deguchi[1,*], **Ikuo Taniguchi**[1,2], **and Tsuyoshi Koga**[1,3]

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Nature is a rich source of inspiration for new scientific advancements, and the deep sea is no exception. High pressure is what most characterizes the deep sea. The pressure in the deep sea steadily increases by 0.1 MPa for every 10 m of water depth and reaches 110 MPa at the deepest point (ca. 11000 m).[1] Ultrahigh pressures above 1 GPa, which can distort crystal lattices, are essential for the development of advanced materials such as room temperature superconductors. The pressure in the deep sea is much lower. Nevertheless, soft materials such as surfactant micelles, lipid membranes, and proteins are affected in various ways by pressures of several tens of MPa. Recently, pressure-responsive soft materials have shown promise in making significant contributions to the development of sustainable solutions.

Baroplastic diblock copolymers exhibit order–disorder transitions (ODTs) and melt upon compression, in some cases even at ambient temperatures (Figure 1).[2,3] The baroplastic behavior is typically observed in block copolymers consisting of a rubbery and a glassy segment. The compressibility mismatch between the two segments plays a critical role in the emergence of the pressure-responsive ODT. We are exploiting the properties of baroplastics to develop sustainable polymers. In this talk, the molecular mechanism of pressure-induced phase transitions and on-demand polymer degradation by pressure will be presented.[4]

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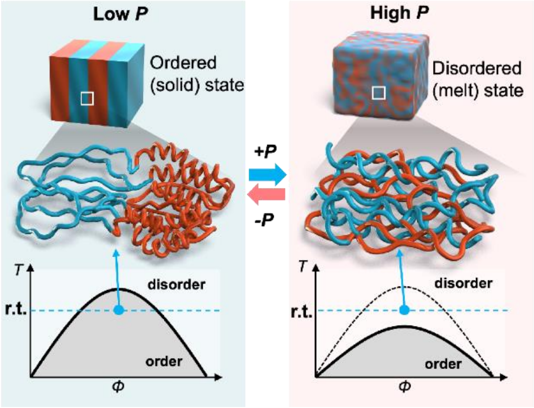

Figure 1. Schematic of pressure-induced ODT of baroplastic block copolymers.[1] ©2023 American Chemical Society.

Keywords: Deep sea / Pressure / Block copolymer / Order-disorder transition / Chemical recycling / On-demand degradation

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SURFACE, INTERFACIAL AND THERMODYNAMIC ASPECTS OF THE BIOSURFACTANT-SALT SYSTEMS

Lalit M. Pandey[1,2*], Anurag Mishra[2], Pankaj Tiwari[2,3]

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Biosurfactants play an essential role in ex-situ microbial-enhanced oil recovery (MEOR). These biomacromolecules possess significant advantages like eco-friendly, non-toxicity and a lower critical micelle concentration (CMC) value over its chemical counterparts. Further, enhanced or tertiary oil recovery involves a surfactant solution along with polymer and alkali or both as a slug. Similarly, the present study investigated biosurfactant-salt systems focusing on surface and interfacial properties. Rhamnolipid was used as a biosurfactant, and various salts like NaCl, Na_2CO_3, $NaNO_3$ were explored. The surface excess of rhamnolipid (2.09×10^{-6} mol/m^2) was reduced to 1.93×10^{-6} mol/m^2 for rhamnolipid-salt systems. This resulted in lowering the interfacial tension and declining CMC values of rhamnolipid to 40–60 mg/L. In the presence of salts, the hydrophobicity of the biosurfactant was also compromised. Further, Gibb's standard free surface energies of rhamnolipid micellization and adsorption at the air-water interface were estimated to predict the thermodynamical behaviour.

Keywords: Biosurfactant; Surface tension; Adsorption and micellization; Contact angle

EXPLORING THE INFLUENCE OF SURFACTANT COLLECTOR BATH CHARACTERISTICS ON THE MORPHOLOGY OF ELECTROSPUN POLYSTYRENE MAGNETITE COMPOSITE FIBERS

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Wet electrospinning is a commonly used method to produce micro/nanofibers using coagulation bath as a collector. The physical and chemical properties of coagulation baths such as surface tension, solubility is known to influence of the morphology of the fibers produced. In our study, we try to determine the influence of individual surfactant properties on the fiber morphology when used as a coagulation bath in electrospinning. Sodium lauryl sulphate (SLS), Triton X-100 (TX100) and cetyltrimethylammonium bromide (CTAB) were used as surfactant collector baths at various concentrations. The binary mixed surfactant solutions also exhibited impressive helicity for the fibers at a lower concentration than the individual surfactant critical micellar concentration. Scanning electron micrograph results further confirm the influence of surfactant properties on the fiber diameter, coil diameter and helicity.

Keywords: Wet electrospinning, Sodium lauryl sulphate, Triton X-100, Cetyltrimethylammonium bromide.

TECHNICAL SESSION XII

Invited Lectures

Chairperson: Prof. Pradeep Kumar Sow

11:20 -11:50 **The revised Hydrophilic-Lipophilic Difference for Ionic surfactants (HLDbi): A bridge between formulation practice and surfactant science**
Edgar Acosta[1]

[1] University of Toronto, Department of Chemical Engineering and Applied Chemistry, 200 College Street, Toronto, ON, Canada, M5S3E5

11:50 – 12:10 **Particle Attributes and Stability of Interfacial Systems in Relation to Pickering Foams**
Sepideh Razavi[1]

[1] Department of Sustainable Chemical, Biological, and Materials Engineering, University of Oklahoma

Oral Presentation

12:10 – 12:30 **Enhancing gas hydrate kinetics using surfactants for desalination applications**
Nagaraju Perapu[1], Srinivas Krishnaswamy[1*], Rajnish Kumar[2]

[1] Birla Institute of Technology and Science (BITS) Pilani, Goa.
[2] Indian Institute of Technology – Madras.

12:30 – 12:50 **Flotation separation of ABS/PS flakes mixture from used refrigeration equipment**
Benita Malinowska[1,2], Konrad Terpiłowski[2]

[1] Polish Recycling Corporation
[2] Maria Curie-Sklodowska University of Lublinj, Department of Interfacial Phenomena

THE REVISED HYDROPHILIC-LIPOPHILIC-DIFFERENCE FOR IONIC SURFACTANTS (HLDbi): A BRIDGE BETWEEN FORMULATION PRACTICE AND SURFACTANT SCIENCE.

Edgar Acosta[1]

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Historically, there has been a divide between the formulation of surfactant-oil-water (SOW) systems and their scientific characterization (via scattering studies) and thermodynamic modeling (curvature-based models). The Hydrophilic-Lipophilic-Difference (HLD) is a practical formulation correlation that indicates the approach to the phase inversion point (HLD=0) of SOW systems considering the surfactant and oil hydrophobicity, the temperature, and the salinity (S) of the system. The net-average curvature (NAC) interprets the HLD as a normalized SOW curvature. The combined HLD-NAC is now a benchmark equation of state for SOW systems. After questions were raised about the curvature interpretation of HLD, a Small-Angle-X-ray Scattering (SAXS) study confirmed this curvature interpretation, only that a new term “bi” had to be introduced for ionic surfactants, such that HLDbi = bi*HLD. The value of bi depends on the ionic surfactant’s molecular structure. This presentation shows how the HLDbi-NAC model allows the use of benchtop SAXS studies to determine the HLD parameters for pure ionic surfactants. These SAXS-based HLD parameters finally help close the loop between the scientific (curvature-based) approaches to studying SOW systems and the formulation of SOW systems in practice.

Keywords: surfactant-oil-water (SOW), emulsions, microemulsions, curvature, SAXS, electrostatic

PARTICLE ATTRIBUTES AND STABILITY OF INTERFACIAL SYSTEMS IN RELATION TO PICKERING FOAMS

Sepideh Razavi[1]

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Presence of complex solutions composed of fluids, ions, surfactant molecules, and colloidal particles is commonplace in problems relevant to materials discovery and manufacturing. Such multicomponent fluidic systems are often confined by interfaces in processes associated with the water-energy nexus as well, for example, in membrane separations and subsurface energy recovery and storage. To make matters more intricate, fluid interfaces are not static and are constantly subject to external disturbances such as thermal gradients, imposed stresses, and changes in composition. Given the environmental and economic impact of the subject matter, it is important to advance our fundamental quantitative understanding of the complex interfacial systems just summarized, with the goal of ultimately predicting and controlling their behaviour in relevant high-tech applications. In this presentation, I will review recent findings in our group on how particle attributes such as wettability and surface anisotropy influence the stability and rheology of fluid interfaces and highlight our findings in mixed surfactant/particle systems. I will discuss the impact of particle surface properties on the interfacial microstructure and flow behaviour, and their connection to the performance in resulting Pickering foams.

Keywords: Particle-laden interfaces, Rheology, Foams

ENHANCING GAS HYDRATE KINETICS USING SURFACTANTS FOR DESALINATION APPLICATIONS

Nagaraju Perapu[1], Srinivas Krishnaswamy[1*], Rajnish Kumar[2]

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Desalination plays a vital role in unraveling the intricate interconnections of energy, water, and the environment, ultimately striving for a more environmentally sustainable world while addressing water scarcity. However, conventional desalination technologies are limited by challenges of high energy consumption, thereby complicating the delicate balance of the water-energy-environment network. Hydrate-based desalination (HBD) offers a ground-breaking solution as an innovative method for seawater to produce water in the form of ice-like structures known as gas hydrates.

Gas hydrates are a type of inclusion compounds where molecules of a gas, called the guest or former, are enclosed within a crystal structure formed by water molecules. The formation of gas hydrates are facilitated under appropriate conditions of high pressure and low temperature. As gas hydrates form, they effectively exclude the dissolved ions and salts, resulting in ice-like hydrate crystals. Subsequently, the dissociation of these crystals results in release of gas leaving behind pure water. The choice of hydrate former plays a significant role in desalination. Amongst the several gases investigated (CO_2, methane, ethane etc.) over the years, ethane exhibits lower equilibrium pressures and optimum dissociation enthalpies which make it a suitable former gas for desalination. Ethane was therefore chosen as the hydrate former in the current study. In addition, there is no reported work on the use of ethane as former for seawater desalination.

The main limitation of HBD however lies in the slow kinetics of hydrate formation and dissociation. Without artificial enhancement, the prolonged induction period, low gas uptake rate, and limited energy storage capacity of hydrates hinder their feasibility for commercial-scale applications like desalination. Surfactants have been identified as a solution to address the aforementioned challenges. The current investigation was done in the presence of Sodium Dodecyl Suphate (SDS), a commonly used anionic surfactant, to explore its potential to alter the formation kinetics of ethane hydrate. The findings reveal a significant reduction in the induction time, down to 2 Hrs from 18 Hrs under conditions of 18 bar pressure and 3^{o}C temperature. The water recovery was 80%. This work highlights the influential role of surfactants in enhancing the ethane hydrate formation process.

Keywords: Sodium dodecyl sulphate (SDS), Hydrate-based desalination (HBD), Seawater, induction period, Hydrate former

FLOTATION SEPARATION OF ABS/PS FLAKES MIXTURE FROM USED REFRIGERATION EQUIPMENT

Benita Malinowska[1,2], **Konrad Terpiłowski**[2]

[1]Polish Recycling Corporation
[2]Maria Curie-Sklodowska University of Lublinj, Department of Interfacial Phenomena

HIPS and ABS are one of the most popular plastics used in electric and electronic devices. However, HIPS and ABS have similar densities and surface properties and these very complicate recycling process of Waste Electrical and Electronic Equipment (WEEE, for example refrigerators). Flotation separation method is the clue of this problem. The aim of this study is to investigate the HIPS and ABS recovery rate by using a mixture of tap water, NaCl and SLES. The flotation solution, which selectively change surface character of these two plastics, was determined in previous researches carried out as a part of the industrial doctoral (DWD/6/0413/2022). HIPS and ABS, in the form of about 2 cm flakes, were obtained from the WEEE processing plant from refrigeration equipment recycling. After flotation HIPS and ABS flakes were identified using the FTIR spectrometer.

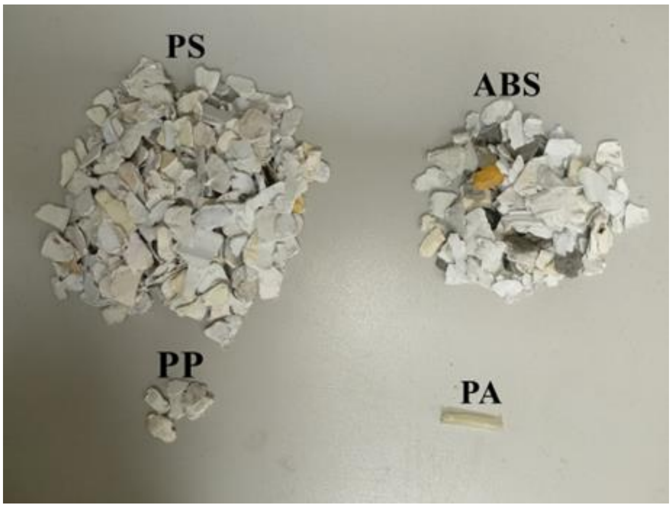

Figure 1. The mixture of plastics (mainly PS and ABS) which was floated.

Acknowledgments:
DWD/6/0413/2022

PLENARY LECTURE 4

Chairperson: Prof. S. S. Bhagwat

AMPHIPHILE SELF-ASSEMBLY DRIVING FORCE, STRUCTURE FORMATION, AND APPLICATIONS

Calum J. Drummond,[1] Tamar L. Greaves,[1] Charlotte E. Conn,[1] Jiali Zhai,[1] Nhiem Tran,[1] Brendan P. Dyett,[1] Saffron Bryant,[1] Sampa Sarkar,[1] and Haitao Yu[1]

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Surfactants, lipids, and many macromolecules are classed as amphiphiles. Amphiphiles (molecules possessing polar and non-polar segments) can utilise their molecular segmentation to self-assemble into highly-ordered structures in some liquids. These amphiphile self-assembly structures can be exploited to create advanced materials.

In Chandler's review in Nature (2005, 437, 640) entitled "Interfaces and the driving force of hydrophobic assembly" he posed the question "Is water special?" with respect to exhibiting the hydrophobic effect. Chandler answered this question with the statement that an important physical feature responsible for hydrophobicity "solute-solvent interactions being significantly less attractive than solvent-solvent interactions are not particularly unusual, at least in the abstract sense." Our work has demonstrably moved this consideration from the abstract domain to experimental validation. Since 2007, the number of non-aqueous solvents which promote the self-assembly of amphiphiles has been increased five-fold (65 new solvents) by us. This allows a different exploration of the molecular "solvophobic effect." This also provides opportunities for the development of new cryopreservation, enzyme catalysis, and protein crystallisation media.

Our fundamental research has also markedly increased the number of known organic molecules capable of self-assembling in solvents to form materials with ordered two-dimensional and three-dimensional internal nanostructures. This significant advance led to design rules which were first developed and then used by us to invent drug delivery technologies, where the drugs are encapsulated in the nanostructured material and diffuse out in a controlled manner to treat cancerous tumours. In recent years this has been extended to the delivery of antimicrobials, mRNA and vaccination.

Keywords: Amphiphile, self-assembly, solvophobic effect, lyotropic liquid crystals, chemotherapeutic agent delivery, antimicrobials

TECHNICAL SESSION XIII

Invited Lectures

Chairperson: Dr. Subit Kumar Saha

16:00 -16:30 **Leveraging surfactant and particle & powder technologies for enhanced performance in industrial applications**
Brij M. Moudgil[1]

[1]Department of Materials Science and Engineering, University of Florida, Gainesville, FL 32653, USA

16:30 – 17:00 **Novel polymeric aqueous dispersant – Atlox 4917**
Hrushikesh J. Mirgal[1]

[1]Croda India

Oral Presentation

17:00 – 17:20 **Hybrid hydrogel sorbents based on natural polysaccharides for extraction of dyes from aqueous solutions**
Benita Malinowska[1,2], Konrad Terpiłowski[2]

[1]Polish Recycling Corporation
[2]Maria Curie-Sklodowska University of Lublinj, Department of Interfacial Phenomena

LEVERAGING SURFACTANT AND PARTICLE & POWDER TECHNOLOGIES FOR ENHANCED PERFORMANCE IN INDUSTRIAL APPLICATIONS

Brij M. Moudgil[1]

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Particulate and surfactant systems are an integral part of a number of industries, including Advanced materials, Energy and Minerals, Pharmaceutical, Healthcare, Cosmetics, Consumer Products, Agriculture & Food, and Microelectronics. Products and/or processes employed, in most industrial applications, depend on the synergistic or competitive interactions between the surfactants/polymers and particles, powders and surfaces. The primary goal of our research has been to generate knowledge and technology platforms, primarily based on the structure-property-performance correlations. Overall objective is to develop application specific platforms for industry to develop more sustainable products and processes. To achieve some of the targeted goals, control of physico-chemical and mechanical properties of surfactant structures, to engineer the formation, removal, and performance of surfactant, and particle coatings on bio and non-biosurfaces. Applications include personal hygiene, chemical-mechanical planarization/polishing (CMP), crop protection, corrosion inhibition, antiscaling agents, and antimicrobial coatings. A judicious selection of reagent schemes and processing parameters is determined to govern the desired performance and product specifications. Surfactant structures and particle and surface morphologies employed depend on the specific industrial application.

In this presentation, select project highlights will be discussed, and challenges and opportunities outlined.

Keywords: Surfactants, particles and powders, bio and non-bio surfaces, CMP, hand hygiene, antimicrobial coatings

NOVEL POLYMERIC AQUEOUS DISPERSANT – ATLOX 4917

Hrushikesh J. Mirgal[1]

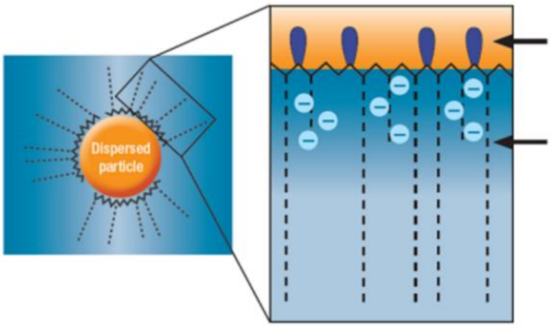
[1]Croda India

Polymeric surfactants are a class of surfactants that deliver high performance and provide superior results which are generally not attainable by conventional surfactants. Polymerics deliver results in technically challenging / demanding applications due to their mode of actions (strong anchoring, steric stabilisation, electrolyte tolerance etc.).

Atlox 4917 is a novel dispersant that is available in Croda's basket of polymeric surfactants, designed for agrichemical applications. The product delivers a unique role as a dispersant that helps to maintain dispersion stability to agrochemical active ingredients during formulation shelf life as well as upon dilution in a farmer's spray tank.

Croda specialise in polymeric dispersants, having a strong understanding of how structure function relationships impact product performance.
Utilising this knowledge, Croda designed Atlox 4917, with its foundation in well-established acrylic polymer chemistry, and draws inspiration from the success of other polymeric structures in the Croda portfolio.

The unique structure of Atlox 4917 combines both steric and electrostatic stabilisation mechanisms as illustrated in Figure 1. This enables Atlox 4917 as a dispersant to exploit the positive effects of both stabilisation mechanisms, whilst offsetting the negatives associated with each one alone. This results in Atlox 4917 having several unique benefits.



Hydrophobic Backbone

Strong anchoring to the dispersed particle through multiple anchoring points along the polymer backbone.

Hydrophilic Side Chains

Three different hydrophilic side chains provide:

- Steric stabilisation through large PEG chains dissolved in the aqueous phase
- Electrostatic stabilisation through ionisation groups located within the polymer
- Hard water/electrolyte tolerance

Figure 1: Structure of Atlox 4917

Key benefits of Atlox 4917

- Compatible with a wide array of agrochemical active ingredients
- Electrolyte tolerant (including both, hard water and glyphosate)
- Effective at low use rate
- Crystal growth control
- Performs a dual function in suspo-emulsion (SE) formulations
- Maintains performance in the presence of agricultural adjuvants

Keywords: Polymeric surfactants, Atlox

HYBRID HYDROGEL SORBENTS BASED ON NATURAL POLYSACCHARIDES FOR EXTRACTION OF DYES FROM AQUEOUS SOLUTIONS

Konrad Terpilowski[1], Nataliia Guzenko[2,3], Mariia Galaburda[1,3], Olena Goncharuk[2]

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[2]Institute of Agrophysics, Polish Academy of Sciences, Doświadczalna 4, 20-290 Lublin, Poland
[3]Chuiko Institute of Surface Chemistry, NAS of Ukraine, 17, General Naumov Str. Kyiv 03164, Ukraine

Dyes pollute waterways as a result of rapidly growing industrial activities. The contaminated water or environment becomes dangerous as dyes can cause life-threatening diseases even in low concentrations and are also toxic. Adsorbents for dye extraction must be efficient, biocompatible and eco-friendly, as well as abundantly available. From this point of view, sorbents based on natural polysaccharides, such as sodium alginate, filled with functional inorganic fillers to regulate mechanical strength and provide additional functional properties, look quite promising. In this study, sodium alginate (SA) composite hydrogels filled with modified montmorillonite (MMT) were prepared by ion cross-linking to produce an interesting low cost, highly effective material for the removal of cationic and anionic dyes (methylene blue (MB) and congo red (CR)) from aqueous solutions. Sodium alginate was ion-crosslinked with a calcium chloride solution, while MMT and MMT modified with CTAB were used as inorganic fillers., Additionally a mixture of MMT and magnetite was also used to achieve sensitivity to magnetite. Magnetite nanoparticles were synthesized by a controlled chemical co-precipitation method under inert atmosphere. The ratio of components in the dried samples of sorbents is given in Table 1. The adsorbents were characterized by X-ray diffraction (XRD), Fourier transform infrared spectroscopy (FTIR) and SEM.

Table 1. Composition of synthesized samples

Sample	SA, %	Filler, %	$CaCl_2$, %	A_{max}, mg/g
N1	50	MMT	0.3	598
N2	50	MMT/CTAB	0.3	641
N3	100%	-	0.3	1183
N4	45.5	45.5%(MMT), 9% (Fe_3O_4)	0.3	569
N5	0	MMT	-	100

The studies have shown that the adsorption isotherms of MB on the synthesized sorbents can be described by the Langmuir isotherm (Fig.1a). The appropriate linearization of the obtained isotherms showed that the best sorption properties are inherent to the unfilled (initial) SA (the maximum adsorption of the alginate hydrogel without filler is 1183 mg/g), whereas hydrogels filled with MMT and a mixture of MMT and magnetite exhibit a sorption capacity in relation to methylene blue of 598 mg/g and 569 mg/g, respectively. Modification of MMT with the surfactant CTAB leads to a slight increase in the sorption capacity of the composite hydrogel to 641 mg/g. Moreover, the synthesized hydrogels show good sorption activity in relation to the anionic dye CR,., The sorption capacity towards CR for composite hydrogels filled with MMT and MMT/CTAB was found to be 275 and 277 mg/g, respectively.

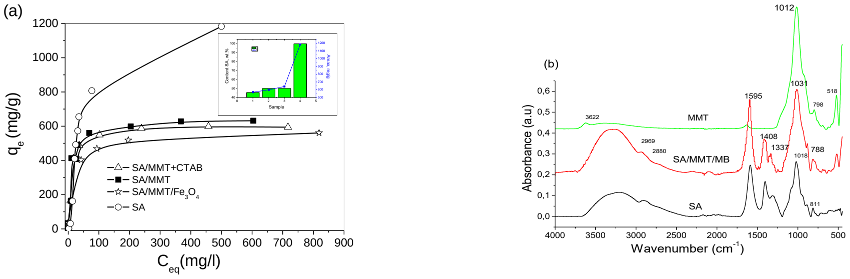

Fig. 1. (a) Adsorption isotherms of methylene blue (MB) on sorbents based on SA hydrogels filled with modified MMT, and (b) FTIR spectra of MMT, SA and composite hydrogel with sorbed MB.

Acknowledgments. Konrad Terpilowski and Nataliia Guzenko thank to International Visegrad Fund for the financial support of this research (Scholarship ID # 52310924).

TECHNICAL SESSION XIV

Invited Lectures

Chairperson: Prof. Amiya. K. Panda

16:00 -16:30 **Characterizations of vesicular structures fabricated from a Pseudotriple-Chainedi ion pair amphiphile**
Jia-Rong Lin[1] and Chien-Hsiang Chang[1]*

[1]Department of Chemical Engineering, National Cheng Kung University, Tainan 701, Taiwan

16:30 – 17:00 **Photo-induced fast and reversible morphological changes in micelles formed by amphiphilic Lophine dimers and their evaluation by insitu SANS measurement**
Hideki Sakai[1,*], Masaaki Akamatsu[2]

[1]Faculty of Science and Technology, Tokyo University of Science, 2641 Yamazaki, Chiba 278-8510, Japan
[2]Faculty of Engineering, Tottori University, 4-101 Koyama-cho Minami, Tottori 680-8550, Japan.

17:00 – 17:30 **Challenges in the design and optimization of the surfactant - based delivery systems**
Prof. Santanu Bhattacharya[1,2,3]
[1]Indian Institute of Science, Education & Research, Tirupati, INDIA
[2]Department of Organic Chemistry, Indian Institute of Science, Bangalore 560012, India
[3]School of Interdisciplinary Sciences, Indian Association for the Cultivation of Science, Kolkata 700 032, India.

CHARACTERIZATIONS OF VESICULAR STRUCTURES FABRICATED FROM A PSEUDOTRIPLE-CHAINED ION PAIR AMPHIPHILE

Jia-Rong Lin[1] and Chien-Hsiang Chang[1,*]

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In this study, negatively charged catanionic vesicles were successfully fabricated from a pseudotriple-chained ion pair amphiphile, prepared from mixed surfactants of dodecyltrimethylammonium bromide and dihexadecyl phosphate, with the addition of cholesterol, and the effects of added cholesterol on the vesicular bilayer characteristics and bilayer phase transition temperature were then explored. The formation of ion pair amphiphile was confirmed by an elemental analysis. The catanionic vesicles were fabricated by using the ion pair amphiphile as the raw material and cholesterol as the additive through a forced formation process. The negative charge character of the catanionic vesicles was evaluate by zeta potential measurements and could be explained by the preferential dissolution of the positively charged moieties of the ion pair amphiphile. The fluorescence polarization and FTIR analyses indicated that by adopting cholesterol as the additive, bilayer fluidity of the catanionic vesicles could be modulated and phase transition temperature of the bilayer structures could be adjusted. It was found that with the addition of a proper amount of cholesterol, phase transition temperature of the vesicular bilayers could be controlled at the appropriate temperature for hyperthermia treatment. This could be attributed to the cholesterol-enhanced hydrophobic interaction in the vesicular bilayer regions. The results suggested that the negatively charged catanionic vesicles prepared from the novel ion pair amphiphile/cholesterol mixture have the potential of being applied as thermosensitive drug delivery carriers.

Keywords: catanionic vesicle, ion pair amphiphile, vesicular structure

PHOTO-INDUCED FAST AND REVERSIBLE MORPHOLOGICAL CHANGES IN MICELLES FORMED BY AMPHIPHILIC LOPHINE DIMERS AND THEIR EVALUATION BY IN SITU SANS MEASUREMENT

Hideki Sakai[1,]*, Masaaki Akamatsu[2]

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[2]Faculty of Engineering, Tottori University, 4-101 Koyama-cho Minami, Tottori 680-8550, Japan.

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Photo-induced control of molecular assemblies formed by surfactants, such as micelles, worm-like micelle and vesicles, enables effective and on-demand release of drugs or active components, with applications such as drug delivery systems (DDS) and cosmetics[1]. However, attempts to optimize the responsiveness of photoresponsive molecular assemblies have been not reported. We previously reported photoswitchable surfactants with a lophine dimer moiety that exhibit fast photochromism in confined spaces, such as inside a molecular assembly. However, rapid control of the micelle structures and solubilization capacity have not yet been demonstrated.

In the present study, photo-induced morphological changes in micelles were monitored using in-situsmall-angle neutron scattering (SANS) and UV/Vis absorption spectroscopy[2,3]. An amphiphilic lophine dimer (3TEG-LPD) formed elliptical micelles. These were rapidly elongated by ultraviolet light irradiation, which could be reversed by dark treatment, both within 60 s. For a solution of 3TEG-LPD micelles solubilizing calcein as a model drug molecule, fluorescence and SANS measurements indicated rapid release of the incorporated calcein into the bulk solvent under UV irradiation. Building on these results, we investigated rapid controlled release via hierarchical chemical processes: photoisomerization, morphological changes in the micelles, and drug release. This rapid controlled release system allows for effective and on-demand DDS.

Keywords: Amphiphilic lophine dimer, Photoswitchable surfactant, Micelle, Small angle neutron scattering,

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CHALLENGES IN THE DESIGN AND OPTIMIZATION OF THE SURFACTANT - BASED DELIVERY SYSTEMS

Santanu Bhattacharya[1,2,3]

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[2]Department of Organic Chemistry, Indian Institute of Science, Bangalore 560012, India
[3]School of Interdisciplinary Sciences, Indian Association for the Cultivation of Science, Kolkata 700 032, India.

Attempts to find suitable and effective means of gene delivery for gene therapy have by and large focused on the use of viruses, which require significant immunological allergic attenuation to render them non-pathogenic. Viruses are currently the most efficient vectors among all candidates for gene delivery and account for more than 75% of ongoing trials (www.wiley.co.uk/genetherapy/clinical). At present, a number of viral-based gene therapy medications have been commercialized; however, the use of viral vectors has been fraught with problems including dangerous side effects, in the worst cases causing death. Furthermore, viral vectors are limited in the number of base pairs of DNA that can fit into the viral capsid, as well as by the possibility of large-scale contamination of batches, high cost of production and undesirable changes during long-term storage. This is where the synthetic surfactants come into play. Bioactive (Drug) delivery is another challenge to selective cells and tissues. A combination of approaches on the design of new vehicles involve the latest trends and attractive option.

I shall present findings of our efforts towards these ends.

POSTER SESSIONS

Effect of gemini surfactant alkyl chain length on self-assembly properties of POE-based nonionic surfactants micellar behavior: An in-depth of scattering study

Virendra Prajapati[1] , Ketan Kuperkar[1*] , Pratap Bahadur[2]

[1]Department of Chemistry, Sardar Vallabhbhai National Institute of Technology (SVNIT), Ichchhanath Dumas Road, Keval Chowk, Surat-395007, Gujarat, INDIA.
[2]Department of Chemistry, Veer Narmad South Gujarat University (VNSGU), Udhna - Magdalla Road, Surat-395007, Gujarat, INDIA.

Determining the mechanisms of the micellization as well as the interactions between molecules within a combination of surfactants mixture

Tejash Desai[1] and Ketan Kuperkar[1]*

[1]Department of Chemistry, Sardar Vallabhbhai National Institute of Technology (SVNIT), Ichchhanath, Surat, 395 007, Gujarat, INDIA.

Co-solvent and Co-surfactant effect of some alkanols and alkanediols on Micellization of a cationic gemini surfactant in aqueous solutions.

Dr. Sureshkumar L. Chavda[1]

[1]Dr. A P J Abdul Kalam Government College, Dadra and Nagar Haveli Ucchh Shikshya Samit, Silvassa, UT of Dadra and Nagar Haveli and Daman and Diu (College is affiliated with Gujarat University, Ahmedabad)

Formation of ethanolamine-mediated surfactant-free microemulsions using hydrophobic deep eutectic solvents

Anjali[1] and Siddharth Pandey[1*]

[1]Department of Chemistry, Indian Institute of Technology Delhi, Hauz Khas, New Delhi – 110016, India.

Aggregates in deep eutectic solvents (DESs): Hydrophilic DES-in-hydrophobic DES novel nonaqueous microemulsions

Anushis Patra, Anjali and Siddharth Pandey*

The "Normalized HLD": The Ultimate Version of the Hydrophilic-Lipophilic-Deviation Equation for Characterizing and Formulating Surfactant/Oil/Water Systems

Prof. Jean-Marie Aubry[1]

Nano Zero-valent Iron (nZVI) stabilized APG (Alkyl Polyglycoside) Surfactant Foam for the remediation of Acephate in Alluvial soil

Ipsita Priyadarshini[1], Chhavi Mishra[1], Banasri Roy[1], Pradipta Chattopadhyay[1]

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Waste plastic as a feedstock for producing surfactants

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Tunable catalytic activity of mixed micelle for the oxidation of benzyl alcohol in aqueous media

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How Polyoxometalates Promote the Aggregation of Cyanine Dyes in the Aqueous Solution of Non-Ionic Copolymers of Varying Hydrophilic–Lipophilic Balance?

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Light-triggered emulsion formation using a protonated merocyanine as a surfactant

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Effect of Oil Type on the Viscoelastic Behavior of Surfactant Film Formed at Oil/Water Interface

Hiroki Kuwabara[1,2], Kyosuke Arakawa[1], Koji Tsuchiya[1], Kenichi Sakai[1], Hideki Sakai[1]

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Role of surfactants on PLA/HA microspheres size and implications for azithromycin release

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Isolation, Screening and Construction of a Microbial Consortium from Formation Water and its suitability for MEOR

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Exploring the Solubilization Behavior of Gelucire® 48/16 and Tetronics® 1304: A Molecular Perspective

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Understanding the Influence of Organic Additives on Phase Behavior and Microstructure: A Comparative Study of Soluplus and Solutol® HS15 Micellar Systems

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Understanding the Interaction Between Ionic Liquids and Amphiphilic Star Block Copolymers

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The effect of ethoxylated alcohols on the sedimentation rate of calcium carbonate. Potential for use in flotation separation of plastics

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Enhancing Emulsion Stability for Oil Recovery: The Synergistic Effects of Surfactants, Nanoparticles, and Polymers

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Saponins in Pithecellobium dulce: Structural Diversity and Surface-Active Potential

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EFFECT OF GEMINI SURFACTANT ALKYL CHAIN LENGTH ON SELF-ASSEMBLY PROPERTIES OF POE-*BASED* NONIONIC SURFACTANTS MICELLAR BEHAVIOR: AN IN-DEPTH OF SCATTERING STUDY

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This research delves into the fascinating influence of cationic gemini surfactants (GS) on the micellization behavior of polyoxyethylene (POE)-*based* nonionic surfactants. We explore how their size dynamically responds to variations in concentration, temperature, and alkyl chain length. Employing a combination of clouding and dynamic light scattering (DLS), we unveil the complex interaction between these molecular associates within micellar structures. Our findings reveal that GS generally induce a decrease effect on POE micelles, except for the interesting case of Soluplus®. These mixed micelles exhibit remarkably compact dimensions, with their properties exquisitely attuned to the interaction of GS concentration and chain length. Particularly, the aggregate architecture arranged by GS exhibits a strong dependence on both concentration and lipophilicity. These noteworthy observations pave the way for the targeted modification of POE-*based* surfactants through GS incorporation, unlocking a plethora of potential applications. To gain a deeper understanding of these intriguing microenvironments, further investigations into the molecular interactions between POE and GS within mixed micelles are highly warranted. Such insights hold immense promise for the design of novel detergents, emulsifiers, and drug delivery systems, ushering in a new era of industrial and biomedical advancements.

Keywords: POE-based nonionic surfactants; gemini surfactants; scattering profile; hydrodynamic size (D_h); polydispersity index (PDI)

DETERMINING THE MECHANISMS OF THE MICELLIZATION AS WELL AS THE INTERACTIONS BETWEEN MOLECULES WITHIN A COMBINATION OF SURFACTANTS MIXTURE

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As a result of their distinctive solution characteristics along with their ability to improve emulsion formation and the dissolution techniques, combined micellar assemblies have become crucial to many analytical and commercial endeavors. Applying a tensiometry methodology, this particular investigation displays the combination of micellization tendency of two different ionized surfactants, sodium oleate (NaOL) and cetyltrimethylammonium bromide (CTAB), in water-based solutions. The surface tension assessments can be utilized for evaluating dynamic alterations within the mixed micellar technique's interface qualities to be an indicator to the CTAB to the mixture with NaOL proportion. The results of this study give an understanding of why overall interaction's pattern and the nature of the respective cleansers determine the concentration of the critical micelle (CMC), which subsequently in response influences the formation of sustainable heterogeneous micelles as well. The physicochemical characteristics associated with the micelle subsequent generations including the influence of surfactants associations on the entire system's activity at the surface can be determined using tension on the surface measurements with it.

Keywords: Surfactants; micellization; mixed micelles; interfacial properties; thermodynamic properties.

CO-SOLVENT AND CO-SURFACTANT EFFECT OF SOME ALKANOLS AND ALKANEDIOLS ON MICELLIZATION OF A CATIONIC GEMINI SURFACTANT IN AQUEOUS SOLUTION

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Critical micelle concentrations (CMCs) and degree of counterion dissociation (α) of gemini surfactant N-N′bis(dimethyldodecyl)-1,4-butanediammonium dibromide (12-4-12) in aqueous solutions in the presence of alkanols viz ethanol, isomeric butyl alcohols, 1-hexanol and alkanediols (ethanediol, 1,4-butanediol, 1,2-hexanediol, 2,5-hexanediol 1,6-hexanediol, and 1,8-octanediol) determined from electrical conductivity are reported. While ethanol, ethanediol, 1,4-butanediol showed an increase in CMC, a decrease was seen for isomeric butyl alcohols, 1 hexanol, isomeric hexanediols and 1,8-octanediol. For butyl alcohols the CMC decrease showed the trend 1° > 2° > N3°; in C6 diols, 1,2-hexanediol exerted more decrease as compared to 2,5-hexanediol and 1,6-hexanediol. The results are explained on the basis of the structure and hydrophobicity of alcohols that determine their effect as cosolvent or cosurfactant (partitioning in micelles). Two-dimensional nuclear overhauser enhancement spectroscopy (2D-NOESY) was used to examine the location for 1-butanol and 1,4-butanediol in micellar systems as representative additives from alkanols and alkanediols showing CMC decreasing and increasing effect respectively.

Keywords: Gemini surfactant, CMC, Alcohol, Micelles

FORMATION OF ETHANOLAMINE-MEDIATED SURFACTANT-FREE MICROEMULSIONS USING HYDROPHOBIC DEEP EUTECTIC SOLVENTS

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Hydrophobic deep eutectic solvents (HDESs) are emerging as versatile, relative benign, and inexpensive alternatives to conventional organic solvents. In this context, formation of microemulsions with HDES replacing oil phase has become an area of active exploration. Due to undesirable toxicity of many common surfactants, efforts are underway to investigate the formation of surfactant-free microemulsions (SFMEs) using HDES as an oil phase. We present SFME formation using HDESs constituted of n-decanoic acid and five (5) structurally-different terpenoids [thymol, L(−)-menthol, linalool, β-citronellol, and geraniol] at 1 : 1 molar ratio as the oil phase and water as the hydrophilic phase. Ethanolamine (ETA) exhibited the best potential as a hydrotrope among several other similar small molecules. Results showed a drastic enhancement in water solubility within the HDESs in the presence of ETA. ETA exerted its hydrotropic action at different extent for each DES system via chemical interaction with the H-bond donor (HBD) constituent of the HDES. Optimum hydrotropic concentration (minimum hydrotrope and maximum water retention,) assigned for each DES/ETA/water system and water loading are reported and the trends are discussed in detail. Ternary phase diagrams are constructed. The area under the single- and multiple- phase regions (assigned in ternary phase diagrams) was estimated. “Pre-Ouzo” enforced by ETA was investigated using dynamic light scattering (DLS) of the DES/ETA/water systems at . A systematic growth in nanoaggregates was observed with subsequent addition of water in DES/ETA systems while continuously changing the existing microstructure. Presence of core (oil)-shell (water)-like structure as indicated by the fluorescence response of Nile red in “pre-Ouzo” region is speculated. We were able to prepare homogeneous solution of [$K_3Fe(CN)_6$] salt in “pre-Ouzo” mixtures with no apparent deviation in Beer-Lambert law.

Keywords: Surfactant Free microemulsion, Hydrophobic DESs, pre-Ouzo.

AGGREGATES IN DEEP EUTECTIC SOLVENTS (DESS): HYDROPHILIC DES-IN-HYDROPHOBIC DES NOVEL NONAQUEOUS MICROEMULSIONS

Anushis Patra, Anjali and Siddharth Pandey*

The versatility of environmentally-benign and inexpensive deep eutectic solvents (DESs) lies in their widely varying physicochemical properties. Depending on its constituents, a DES may be highly polar or highly nonpolar in nature. This offers enticing possibility of formation of novel nonaqueous microemulsions (MEs). Evidence of the presence of polar DES-in-nonpolar DES MEs is presented with reline (formed by mixing choline chloride and urea in 1 : 2 mole ratio) as the polar DES forming the MEs pools, (Thy : DA) [formed by mixing thymol (Thy) and *n*-decanoic acid (DA) in 1 : 1 mole ratio] nonpolar DES as the bulk oil phase, and nonionic surfactant Brij-35 as the emulsifying agent. While only sparingly miscible in (Thy : DA), as high as 2.5 M reline can be solubilized in this DES in the presence of 100 mM Brij-35; reline loading (w_{Rel} = [reline]/[Brij-35]) of as high as 60 can be achieved. Ternary phase diagram of (Thy : DA)/Brij-35/reline system reveals clear and transparent single-phase region where MEs may be forming. Dynamic light scattering (DLS) confirms the presence of MEs of 2 - 10 nm size. Even as up to 2.5 M (ca. 0.35 mole fraction) reline, whose dynamic viscosity (η) and electrical conductivity (κ) are very high, is added to 100 mM Brij-35 solution of (Thy : DA), the η and κ of the solution increases insignificantly thus conforming formation of MEs in the solution. FTIR absorbance spectra and fluorescence probe responses further indicate that reline is not dispersed in the medium, it rather forms polar pools of the MEs. These novel nonaqueous polar DES-in-nonpolar DES MEs will not only expand application potential of DESs, they also offer new class of organized media with widespread potential.

THE “NORMALIZED HLD”: THE ULTIMATE VERSION OF THE HYDROPHILIC-LIPOPHILIC-DEVIATION EQUATION FOR CHARACTERIZING AND FORMULATING SURFACTANT/OIL/WATER SYSTEMS

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The introduction of the HLB concept in 1949 marked a breakthrough in characterizing the amphiphilicity of *ethoxylated surfactants* but it is inappropriate for other types of surfactants. In contrast, Salager’s HLD equation effectively captures the true hydrophilic/lipophilic tendency of surfactants because it is based on the scientifically sound concept of *"optimal formulation”*. However, it encompasses parameters that are laborious to measure and the numerical value of HLD, expressing the deviation from optimal formulation, is difficult to grasp intuitively. Recently, a simplified HLD equation, denoted HLD N , has been proposed [1]. The physical significance of the HLD_N value is clear, as it is expressed in units of ACN, which represents the carbon number of the n-alkanes acting as oil in SOW systems (Eq. 1).

$$HLD_N = PACN - ACN + \tau.(T - 25) + \delta.S \quad (1)$$

- PACN is the “Preferred ACN” of the surfactant expressing its hydrophilic/lipophilic tendency under standard conditions. When ACN equals PACN at 25°C, a three-phase system (Winsor III) forms spontaneously.
- T is the temperature and S the salinity
- τ and δ reflect the surfactant sensitivity towards temperature and salinity respectively.

HLD_N greatly facilitates the selection of surfactants for a given application, such as oil solubilization or the design of micro- and macro-emulsions with predefined morphology and stability. In addition, two novel fast and simple methods for reliably measuring the hydrophilic-lipophilic tendency of surfactants will be described: PIT-slope for electrolyte-free environments and SPI-slope in the presence of salts. Finally, the remarkable capability of COSMO-RS theory in predicting non-ionic surfactant hydrophilic-lipophilic tendencies will be showcased. This “first principle” methodology relies solely on molecular structures of oils and surfactants without requiring experimental input.

Keywords: Amphiphilicity, Normalized HLD, Optimal Formulation, PIT-slope, SPI-slope, COSMO-RS.

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NANO ZERO-VALENT IRON (NZVI) STABILIZED APG (ALKYL POLYGLYCOSIDE) SURFACTANT FOAM FOR THE REMEDIATION OF ACEPHATE IN ALLUVIAL SOIL

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Pesticides, such as Acephate, are utilized for controlling disease vectors and pests. However, long-term ramifications of pesticide usage reveal various adverse effects of agricultural soil, human health, crop production etc. This paper presents a study on the remediation of acephate - contaminated alluvial soil using APG (Alkyl Polyglycoside) surfactant foam stabilized with zero-valent Iron nano particles (nZVI). nZVI are synthesized using a liquid phase reduction method employing ferrous chloride and sodium borohydride. The X-Ray diffraction (XRD), Field emission scanning electron microscopy (FE-SEM), Raman spectroscopy, X-ray photoelectron spectroscopy (XPS), etc, are utilized to study the physico-chemical characteristics of the nZVI. The effect of these nanoparticles on foamability, foam stability, surface tension and remediation of acephate contaminated soils are examined at various concentrations (volume%) of alkylpolyglucoside phosphate (APG-Ph) surfactant and nanoparticles (mg/l). These findings suggest that nanoparticle-stabilized foams could present a cost-effective, environmentally friendly commercial solution for soil remediation in the future.

Keywords: nZVI, Alluvial Soils, APG Surfactant Foam, Acephate, Soil Remediation

WASTE PLASTIC AS A FEEDSTOCK FOR PRODUCING SURFACTANTS

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As part of clean future commitment, Unilever Home Care has committed to move away from its dependence on fossil carbon for the chemical ingredients in its formulations, through exploring various renewable and recyclable carbon sources for ingredients in our products using the Carbon Rainbow [1]. For this transition of chemical feedstocks from petroleum to sustainable sources, sources like plastic waste, biogenic carbon, and captured carbon could be considered.

In this context, we have worked on waste plastic as a feedstock for producing key chemical intermediates such as paraffins and aromatics. When the waste plastic was treated at higher temperatures in the absence of air, the plastic depolymerized to yields ‘pyrolysis oil’. C10-C13 n-paraffins and aromatics were then extracted from pyrolysis oil. The extracted C10-C13 alkane chain and commercial benzene were used to synthesize linear alkyl benzene sulphonate via alkylation and sulphonation reactions, yielding ‘recycled’ LAS surfactant from plastic waste. This synthesized LAS was characterized against commercial LAS on micellization, surface activity and foamability.

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TUNABLE CATALYTIC ACTIVITY OF MIXED MICELLE FOR THE OXIDATION OF BENZYL ALCOHOL IN AQUEOUS MEDIA

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The binary surfactant producing mixed micellar microenvironment provides influencive catalytic effect compared to the single surfactant generated micellar media for the present diperiodatoargentate(III) (DPA) governed oxidation study. The CMC for all binary compositions has been determined by conductometric and fluorometric approaches. Interestingly, the NMR study confirms the presence of CPC and Brij-35 in mixed micelle with 1: 2 ratios. Noticeably, the presence of equimolar surfactants in mixed micellar composite enhanced the rate of oxidation process with the reduction of reaction time from 24 hrs to just 5 min. The favourable micellization by CPC and Brij-35, increased solubilization of benzyl alcohol in mixed micelle, and significant electrostatic attraction of negatively charged Ag(III) metal centres with the CPC/Brij-35 nanostructures have been attributed to assess the synergistic effect of studied micellar media in oxidation process. The kinetics of oxidation has been monitored by UV-Vis spectrophotometer while zeta potential, DLS, and ^{1}H-NMR study offers the evidences to support the proposed mechanistic approach for the oxidation process. Therefore, the employment of binary surfactant media reduces the reaction time, the total amount of surfactant, and also the environmental impact.

Keywords: Micellar Catalysis, Mixed Micelle, Oxidation, Green Transformation

HOW POLYOXOMETALATES PROMOTE THE AGGREGATION OF CYANINE DYES IN THE AQUEOUS SOLUTION OF NON-IONIC COPOLYMERS OF VARYING HYDROPHILIC–LIPOPHILIC BALANCE?

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The non-radiative pathway leading to the photoisomerization of a cyanine dye is well-established information. 1 However, the modulations induced in the photoisomerization pathway by a Keggin-type polyoxometalate in a confined media is albeit new. Our study reveals that in the presence of F-108 and P-123, phosphomolybdic acid hydrate (PMA) promotes the aggregation of 3,3 ' -Diethylthiadicarbocyanine iodide (DTDCI). UV studies denote a clear indication of a red-shifted trimer band in F-108 and P-123 whereas, it is absent in F-127 and P-84. Fluorescence emission studies suggest that in the presence of PMA, the rate of photoisomerization is accelerated in F-108, P-123, and P-84 micelles whereas it is retarded in F-127 micelles. Time-resolved studies in the presence of PMA indicate the preference of F-108, P-84, and P-123 towards the trapped conformer of DTDCI whereas, F- 127 favours the ground state photo-isomer of DTDCI. Our findings imply the importance of the interplay between the hydrophobic and electrostatic interactions between the DTDCI cations and the PMA anions in non-ionic micelles of varying hydrophilic-lipophilic balance (HLB). DLS data suggest a modulation by PMA in the inter micellar electrostatic repulsions of a hydrophilic copolymer micelle whereas, it is unaffected in a hydrophobic copolymeric micelle.

Keywords: Photophysics, Block-Copolymer, Keggin POM, Photoisomerization

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LIGHT-TRIGGERED EMULSION FORMATION USING A PROTONATED MEROCYANINE AS A SURFACTANT

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The control of interfacial activities by photo-stimulations has been studied extensively due to its ease of switching. Several studies have been reported on the photocontrol of dispersion stability of emulsions[1,2] , but most of them focused on the photoisomerization of the cationic azobenzenes. The difficulties in this case are the similarity of the two irradiation light wavelengths required for the switching and the use of cationic surfactants with low biocompatibility. In this study, we report that the dispersion stability of emulsions was greatly improved by using an alkyl chain substituted merocyanine in oil and acidic water mixture. Spiropyrans are changed merocyanines by the photo-isomerization from the charge-neutral state to the zwitterion state upon irradiation with ultraviolet and red light. When they are merocyanines, the molecules can be formed into cationic state by protonation under acidic conditions. Thus, it is considered that protonated merocyanine adsorbed at the oil-water interface and lowered the interfacial tension by working like a surfactant. In this presentation, we will report the evaluation of the pH dependence in the dispersion stability.

Keywords: Spiropyran, Merocyanine; Emulsions; Light-triggered; Photo-isomerization

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EFFECT OF OIL TYPE ON THE VISCOELASTIC BEHAVIOR OF SURFACTANT FILM FORMED AT OIL/WATER INTERFACE

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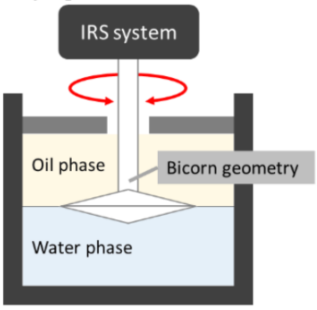
Emulsions are utilized in various industries, such as pharmaceuticals, cosmetics, and food, due to their ability to incorporate both water- and oil-soluble components simultaneously. However, emulsions are metastable systems, and the dispersed droplets coalesce with each other and eventually separate into two phases. The ease of coalescence is correlated with the viscoelasticity of the surfactant film at the oil/water interface. Hence, it is important to clarify the viscoelastic properties of the oil/water interfacial film to evaluate coalescence resistance.

In recent years, measurements of interfacial viscoelasticity by using a stress-controlled rheometer with a bicone geometry have attracted significant attention. The viscoelastic behaviour of the interfacial film with Span65 (sorbitan tristearate), a nonionic surfactant, formed at the dodecane/water interface by has been reported[1]. The dispersion stability of emulsions is also affected by the properties of oil species. This study aims to elucidate the effect of oil type on the viscoelastic behavior of the oil/water interfacial film formed by Span 65.



Schematic representation of interfacial rheology measurements (IRS).

The viscoelastic behavior of Span65 films formed at the interface between water and saturated hydrocarbons with various alkyl chain lengths was evaluated. Interestingly, when the difference in alkyl chain length between Span 65 and the hydrocarbon was large, the viscoelasticity of the interfacial film was high, while the difference was small, the viscoelasticity was low. This change in the viscoelasticity of the interfacial film was considered from the perspective of the interaction between the oil phase and the stearyl group of Span65.

Keyword: Interfacial Shear Rheology, Oil /Water interface, Emulsions

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ROLE OF SURFACTANTS ON PLA/HA MICROSPHERES SIZE AND IMPLICATIONS FOR AZITHROMYCIN RELEASE

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Exploring surfactant’s effects on microsphere properties is a fundamental pursuit in drug delivery and pharmaceutical research. This is due to surfactants exerting significant influence over microsphere size, distribution, and release kinetics. The attainment of an optimal size distribution is crucial for addressing clinical challenges such as toxicity and ensuring drug release occurs within the therapeutic window. To address these challenges, we optimized surfactant concentration by synthesizing polylactic acid (PLA) microspheres at varying concentrations of surfactant, ranging from 0.2% to 0.5%. Utilizing these optimized parameters, we created composite microspheres loaded with azithromycin (AZM) by blending PLA and hydroxyapatite (HA) using the double emulsion solvent evaporation method. The resulting composite microspheres were then analyzed using high-resolution scanning electron microscopy (SEM), revealing a spherical morphology with an average particle size ranging from 58 µm to 120 µm. In vitro release studies confirmed a sustained AZM release from the composite microspheres. These findings highlight the importance of surfactant optimization in refining drug delivery systems and potentially improving therapeutic outcomes.

Keywords: Composite microspheres, surfactant, polyvinyl alcohol, drug release, double emulsion solvent evaporation

ISOLATION, SCREENING AND CONSTRUCTION OF A MICROBIAL CONSORTIUM FROM FORMATION WATER AND ITS SUITABILITY FOR MEOR

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The continuous depletion of petroleum from traditional crude oil reservoirs is a result of the world's population growth, economic expansion, increased energy use, and intense industrialization. Due to this, numerous studies to recover the final two-thirds of the trapped original oil in situ (OOIP) have been intensified. Accordingly, research has been done on tertiary oil recovery techniques such thermal, chemical, and microbial methods to expedite and expand the extraction of unrecovered crude oil. It is widely acknowledged that biological preparations comprising many symbiotic microbial isolates are significant due to their superior biotechnological properties and improved efficacy over monobacterial formulations. The isolation of possible biosurfactant & biopolymer producing, gas-forming and crude oil-degrading strains from the stock tank formation water samples of various oil collecting unit of Assam oil field production facilities is thoroughly described in the current work. A total of ten strains were isolated, and the growth of these strains was examined on Bushnell Haas agar enriched with crude oil. Based on its surface-active characteristics and growth profile, five strains (FD1, FD2, FD3, FK4 and FK5) were selected for further investigation. Surface tension and interfacial tension were lowered when grown in nutrient broth medium in the range of 24 – 49 mN/m and 0.02 – 1.73 mN/m, respectively. Furthermore, each strain was individually examined for emulsification of oil, production of biofilm, biosurfactant and the generation of gas and acids. The biosurfactant and biopolymer extracted were also chemically characterized using FTIR and H-NMR. Antagonistic activity of the five indigenous bacterial isolates were examined by cross streaking and later on consortium was compared and constructed on the basis of their surface-active properties.

Keywords: Biopolymer, Biosurfactant, Crude oil, Consortium, Formation water, Strain isolation

EXPLORING THE SOLUBILIZATION BEHAVIOR OF GELUCIRE® 48/16 AND TETRONICS® 1304: A MOLECULAR PERSPECTIVE

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In this study, we have discussed the behaviour of two nonionic surfactants, Gelucire® 48/16 and Tetronic® 1304, which are based on polyethylene glycol (PEG). We used different analytical techniques such as cloud point (CP), dynamic light scattering (DLS), small-angle neutron scattering (SANS), Fourier transform infrared spectroscopy (FT-IR), UV spectrophotometry, and high-performance liquid chromatography (HPLC) to study the micellar and solubilizing properties of these surfactants in the presence and absence of salt. We evaluated the solubility of quercetin (QCT) as a model compound because of its pharmacological properties. Our results show that QCT and surfactant molecules interact strongly, leading to increased solubility. We found that the presence of salt significantly improved the micellar size and solubilizing ability while decreasing the cloud point. Gelucire® 48/16 demonstrated better performance than T1304, exhibiting a remarkable increase in QCT solubility in the presence of salt. Thus, it has the potential to be an effective nanocarrier for various pharmaceutics, leading to improved therapeutic outcomes. Our research provides valuable insights into the development of nanocarriers for enhancing drug solubility and efficacy. It paves the way for innovative pharmaceutical formulations.

Keywords: Nonionic surfactants, Polyethylene glycol, Micelles, Quercetin, T1304, Gelucire® 48/16,

UNDERSTANDING THE INFLUENCE OF ORGANIC ADDITIVES ON PHASE BEHAVIOR AND MICROSTRUCTURE: A COMPARATIVE STUDY OF SOLUPLUS AND SOLUTOL® HS15 MICELLAR SYSTEMS

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In this study, we examined the behavior of two non-ionic surfactants, as well as the comparative study of soluplus and solutol® HS15. Soluplus, an amphiphilic graft copolymer, revolutionizes drug solubility with its HLB of approximately 14, forming stable micelles even at low concentrations. Solutol HS15, a versatile non-ionic surfactant, bridges the gap between lipophilic and hydrophilic realms with an HLB value of 14 to 16, promising low toxicity and efficacy in managing multi-drug resistance. The comparison of these surfactants in different additives including denaturants such as urea, methyl urea, and dimethyl urea, sugars like glucose, fructose, mannitol, sucrose, maltose, and lactose, alcohols such as methanol, ethanol, propanol, 1-butanol, ethanediol, 1,3-propanediol, and 1,4-butanediol, inorganic salts like NaF, NaCl, NaBr, Nal, $NaNO_3$, KCL, KBr, and KI, and amino acids such as alanine, glycine, lysine, valine, and cysteine hydrochloride. We found that additives with higher hydrophobicity caused a considerable decrease in the cloud point, while those with a more hydrophilic nature tended to increase it. Our findings will be highly advantageous in the use of these non-ionic surfactants in various industrial and pharmaceutical applications.

Keywords: Non-ionic surfactants, amphiphilic graft copolymer, Additives, Hydrophobicity, Hydrophilicity

UNDERSTANDING THE INTERACTION BETWEEN IONIC LIQUIDS AND AMPHIPHILIC STAR BLOCK COPOLYMERS

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In this study, we present a comprehensive analysis of the physicochemical properties of a star block copolymer, Tetronic® 1304 (T1304), which is made up of ethylene oxide and propylene oxide (EO-PO), with a total molecular weight of 10,500 and a 40% PEO content. The purpose of the analysis is to investigate the impact of an ionic liquid (IL) - 1 alkyl-3-methylimidazolium-based - on the copolymer, using various techniques such as cloud point (CP), viscosity, dynamic light scattering (DLS), small-angle neutron scattering (SANS), high sensitivity differential scanning calorimetry (HSDSC), fluorescence measurement, and 1H NMR spectroscopy. The results show that at lower concentrations, ILs with different anions had the same effects on the micelles of T1304, but at higher concentrations, significant changes were observed. ILs with longer alkyl chains formed smaller mixed micelles while remaining in the bulk with shorter chains. Additionally, the CP increased significantly with an increase in the alkyl chain length, while the apparent hydrodynamic diameter (Dh) of micelles decreased. The presence of NaCl suppressed the effect of IL on T1304 micelles. SANS data explained the microstructural changes observed in T1304 micelles in the presence of different ILs. Fluorescence studies with coumarin-481 as a probe showed shifts in the emission spectra and an enhancement in the fluorescence decay, indicating the incorporation of the IL in micelles. The penetration of ILs with longer alkyl chains in T1304 micelles was further confirmed by 1H NMR spectroscopy. This study provides vital information on how ILs can be used to tune the solution behavior of T1304 for various industrial applications.

Keywords: Star block copolymer, Ethylene oxide and Propylene oxide, Ionic Liquids, Mixed micelles

THE EFFECT OF ETHOXYLATED ALCOHOLS ON THE SEDIMENTATION RATE OF CALCIUM CARBONATE. POTENTIAL FOR USE IN FLOTATION SEPARATION OF PLASTICS

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This research investigates the effect of non-ionic surfactants so ethoxylated alcohols on the calcium carbonate suspension sedimentation rate in tap water. First, 30% calcium carbonate suspensions in tap water were prepared and the time of sedimentation was measured. Then different kinds of surfactants were tested and the stabilities of dispersions were examined. The aim of this study is to determine the potential of using ethoxylated alcohols as a surfactants which improve sedimentation rate and are applicable for flotation separation of plastics obtained from Waste Electrical and Electronic Equipment (WEEE).

Figure 1: The mixture of plastics (mainly PP and ABS) obtained from postconsumer washing machines (WEEE).

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ENHANCING EMULSION STABILITY FOR OIL RECOVERY: THE SYNERGISTIC EFFECTS OF SURFACTANTS, NANOPARTICLES, AND POLYMERS

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Achieving stable emulsions under harsh reservoir conditions characterized by high temperatures and salinity is crucial for effective oil recovery strategies. This study explores the colloid-chemical properties of surfactants (CTAB, DoTAB), polymers (polyacrylamide), and nanoparticles (SiO2) to develop optimal emulsifier compositions and stabilize emulsions in such environments. Our systematic experimental approach focused on the interactions of these agents in bulk and at interfacial boundaries, contributing to an enhanced understanding of emulsion dynamics.

We investigated physicochemical interactions within binary and ternary nanofluid systems comprising CTAB, DoTAB, polyacrylamide, and SiO_2 nanoparticles. Key findings include a marked improvement in emulsion stability facilitated by the synergistic interactions among these components. For instance, adding SiO_2 nanoparticles to surfactant solutions significantly decreased the equilibrium and dynamic surface tensions, indicating enhanced surface activity crucial for stable emulsion formation.

Modified polyacrylamide polymers, combined with surfactants and nanoparticles, demonstrated increased viscosity and stability under simulated reservoir conditions, highlighting their potential as oil-displacing agents. Furthermore, studies have found that these three-component systems display distinct electrokinetic properties, such as altered zeta potentials and particle size distributions. These properties are crucial in tailoring the interfacial characteristics required for efficient oil displacement. The zeta potential measurements across various surfactant concentrations underscored the importance of surfactant-nanoparticle interactions, with optimal conditions identified at CTAB concentrations of 3-3.5 mmol/L for achieving the desired composite properties. Additionally, the study of the surfactant hydrocarbon chain length provided insights into its influence on the systems' physicochemical properties, revealing critical concentration range where stable zeta potentials and effective surface modifications occur.

Keywords: emulsion stability, nanofluid systems, surfactants, silica nanoparticles, polyacrylamide, EOR

SAPONINS IN PITHECELLOBIUM DULCE: STRUCTURAL DIVERSITY AND SURFACE-ACTIVE POTENTIAL

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Plants produce a diverse array of metabolites, classified into primary and secondary metabolites. Primary metabolites include carbohydrates, fats, and proteins, while secondary metabolites, such as alkaloids, flavonoids, terpenoids, saponins, and phenols, serve various functions beyond basic cellular processes. Secondary metabolites are notable for their applications in pharmaceuticals, food additives, flavors, fragrances, and agrichemicals.

Among these, saponins are widely distributed across many plants and exhibit extensive structural and functional diversity. Saponins are categorized into triterpenoidal and steroidal saponins, based on the nature of their aglycone. The sapogenin represents the aglycone component, whereas oligosaccharides typically constitute the glycone part of saponins. The effectiveness of a surfactant is determined by its ability to reduce surface tension, with more efficient surfactants exhibiting lower critical micelle concentrations (CMC). Due to their physicochemical, biological, and surface-active properties, saponins have a wide range of traditional and industrial applications, including use as natural detergents.

This research aims to investigate the surface-active parameters of saponins extracted from the leaf, fruit,stem, and bark of Pithecellobium dulce (Roxb.) Benth and explore their potential application in herbal-based cosmetic formulations. By evaluating the surfactant properties of these saponins, we aim to contribute to the development of effective and natural cosmetic products that harness the unique benefits of plant-derived saponins.

Keywords: Primary metabolites, secondary metabolites, saponins, triterpenoidal saponins, steroidal saponins, surface-active properties, critical micelle concentration (CMC), Pithecellobium dulce (Roxb.) Benth, herbal-based cosmetics, natural detergents, sapogenin, glycone.

TECHNICAL SESSION XV

Invited Lectures

Chairperson: Dr. Saurabh Patankar

09:00 – 09:30 **Structural effect of surfactants on the compaction of ct-DNA in the presence of silica nanoparticles: Presenting highly efficient gene delivery vectors**

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Mumbai, Maharashtra 400085, India

09:30 – 10:00 **Structure-Property-Energetics relationships in drug partitioning and release employing colloidal selfassemblies: mechanistic insights**

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STRUCTURAL EFFECT OF SURFACTANTS ON THE COMPACTION OF CT-DNA IN THE PRESENCE OF SILICA NANOPARTICLES: PRESENTING HIGHLY EFFICIENT GENE DELIVERY VECTORS

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Cationic surfactants act as non-viral vectors and effectively compact DNA; however, cytotoxicity associated with them is a challenge. Efforts to mitigate this challenge include modifying surfactant structures, such as sizes of headgroups, or tail lengths and changing chemical structures of spacers in gemini surfactants. Another approach is to use suitable nanoparticles. Here, compaction of calf thymus DNA (ct-DNA) by some cationic one-head-two-tail surfactants with variable tail lengths (DDAB12, 16 and 18), gemini surfactants with different spacer chain lengths (12-4-12, 12-6-12, and 12-8-12), and three-head-two-tail surfactant (MQAS12) in the presence of silica nanoparticles have been studied and compared with the conventional surfactant DTAB. The study reveals DDAB group surfactants as highly efficient gene delivery vectors to compact ct-DNA, addressing cytotoxicity issues. The structural effects of surfactants on compacting ct-DNA in the presence of silica nanoparticles have been demonstrated with the help of an empirical rule. The study shows that along with electrostatic interactions, the hydrophobicity per unit surface area (*P*) of silica nanoparticles induced by surfactants has a significant role in the compaction of DNA. One-head-two-tail surfactant exhibits a large amount of adsorption on the nanoparticles' surfaces, producing a large *P*. Circular dichroism (CD) spectral data shows the surfactants as DNA's intercalative binders. Fluorescence anisotropy decay analysis reveals the segmental dynamics of ct-DNA in the presence of surfactants. Biological testing has been carried out, including cell viability of mouse mammary gland adenocarcinoma cells (4T1) and human embryonic kidney (HEK) 293 cell lines and *in vitro* and *in vivo* cellular uptake of the gene to 4T1 cell line. The study provides ideas for designing efficient non-viral vectors for DNA compaction, presenting some vectors to be applied as nucleic acid carriers for biomedical applications.

Keywords: ct-DNA compaction, Hydrophobicity of silica nanoparticles' surfaces, 1-2 and 2-2 types surfactant, Surfactants' structural effect, Effect of nanoparticle size

STRUCTURE-PROPERTY-ENERGETICS RELATIONSHIPS IN DRUG PARTITIONING AND RELEASE EMPLOYING COLLOIDAL SELF-ASSEMBLIES: MECHANISTIC INSIGHTS

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Majority of synthetically developed new molecular entities or improved drug molecules have high hydrophobic content and low bioavailability. Therefore, suitable drug delivery vehicles are required for effective delivery of the drugs at the target site. Self-assembled hydrocolloidal structures such as surfactant micelles, niosomes, and liposomes offer an effective environment for drug encapsulation. Literature information on drug encapsulation in such self-assemblies has generally been qualitative in nature. We have quantitatively investigated the partitioning of a variety of drugs varying from antibiotic, anticancer, anti-inflammatory and antithyroid into self-assemblies of cationic, non-ionic and mixture of cationic and non-ionic surfactant micelles, as well as of niosomes and their interaction with the transport protein serum albumin upon subsequent delivery. Thermodynamic signatures accompanying the partitioning process [such as partitioning constant (K) and change in standard molar enthalpy (ΔHmo) , standard molar entropy (ΔSmo), and standard molar free energy (ΔHmo)] have enabled a quantitative understanding of the role of functional groups on the drug molecule and properties of the self-assemblies in encapsulation along with loci of partitioning. It is also observed that self-assemblies of non-ionic molecules allow partitioning of drug molecules in a sequential manner. Experiments on interactions of drug molecules upon release from such assemblies with the target protein have suggested that the binding process is not appreciably different than in that in the absence of self-assemblies. The effect of drug delivery vehicles on the thermal and structural stability of target protein (taken as transport protein bovine serum albumin and human serum albumin) have been investigated quantitatively. The results have been correlated with different class of drugs of different nature to understand the role of molecular features in the partitioning process. These studies have significance in understanding the physical chemistry underlying partitioning of a variety of drug molecules into suitable delivery vehicles and permit establishing structure-property-energetics relationships.1-4 Such studies provide general guidelines towards a broader goal of rational drug design.

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