Biomaterial Interfaces
Room Ballroom A - Session BI-ThP
Biomaterial Interfaces Poster Session

BI-ThP-1 Interactions of KSCN with Phospholipid Monolayers Studied by Sum Frequency Generation and X-Ray Fluorescence, ***Sadia Afroz***, Pennsylvania State University; *Bastian Mueller, Emanuel Schneck,* TU Darmstadt, Germany; *Paul S. Cremer,* Pennsylvania State University

Thiocyanate (SCN^-) is a weakly hydrated anion that can interact relatively strongly with lipid membranes compared to other anions in the Hofmeister series. To date, the specific mechanisms governing this processes remain poorly characterized. To shed light on ion-lipid membrane interactions, we introduced KSCN into the subphase below 1,2-dilauroyl-sn-glycero-3-phosphocholine (DLPC) monolayers. This saturated lipid was chosen because it remains in the fluid phase at room temperature. Both the two-dimensional pressure of the monolayer and the salt concentration were varied. SFG was used to follow vibrational signals associated with the interfacial water structure, the lipid headgroups, the ordering of the alkyl chains, as well as the SCN^- anions. Such data are vital for characterizing the system, but the concentration of interfacial ions is not directly quantifiable. As such, we also employed total reflection X-ray fluorescence which can monitor the interfacial concentration of both K^+ and SCN^- concentrations. Details of these interactions as well as their implications for Hofmeister chemistry will be discussed.

BI-ThP-2 The Neurotoxin Vipoxin Induces Changes in Mechanical Properties of Breast Epithelial Cells, *William Linthicum,* Oxford Instruments; *Qi Wen,* ***Nancy Burnham***, Worcester Polytechnic Institute; *Svetla Petrova, Konstantin Balashev,* Sofia University, Bulgaria

The investigation of how drugs or toxins alter cell mechanics is gaining significant traction in biomedical science, driven by the dual objectives of elucidating their mechanisms of action and enhancing drug screening processes. In this study, Atomic Force Microscopy (AFM) was employed to examine and analyze the mechanical responses of cells exposed to the neurotoxin Vipoxin. This method enables the precise measurement of key mechanical parameters such as cell stiffness and viscoelasticity before and after toxin introduction in the cell culture. It was demonstrated that the cells' stiffness and viscosity decreased with increasing Vipoxin concentration. Additionally, Total Internal Reflection Fluorescence Microscopy (TIRFM) was utilized to monitor morphological changes in the cells over time. These morphological changes were quantitatively analyzed using fractal analysis of the acquired images. The observed changes in cell shapes implied the reorganization of the cell cytoskeleton, thus providing insight into the cell mechanics under the influence of Vipoxin.

BI-ThP-3 Sustainable Bioinspired Polymer–Mineral Composites for Adaptable Repair in Conservation Applications, ***Zoe Weber-Porter***, *Rishima Agnihotri, Ashwin Marichetty, Marco Rolandi,* UC Santa Cruz

Every year, tens of thousands of tons of plaster-based materials are used in restoration and conservation applications, many of which are derived from non-renewable sources and discarded at the end of their service life. Here, we introduce a biodegradable, bio-derived composite based on chitosan and calcium carbonate that is composed of simple, widely available constituents and designed for adaptable repair applications. By varying polymer molecular weight, concentration, and mineral content, the composite can be formulated to span injectable, paste-like, and putty-like behaviors, enabling accommodation of diverse structural filling and stabilization needs. We examine relationships between composition, flow behavior, and mechanical performance through rheological characterization of the wet composite and measurements of bulk density, porosity, and compressive strength in the hardened state. Rather than targeting a single optimized formulation, this work demonstrates a tunable material platform in which relationships between composition, flow behavior and mechanical performance guide selection of material behavior based on application requirements. Future applications of this approach include sustainable repair and conservation materials for exhibits, architectural restoration, and other contexts where adaptable handling, mechanical integrity, and biodegradability are desired.

BI-ThP-5 Pulsed Plasma Surface Functionalized Nanosilver for Gene Delivery, ***Ajinkya Trimukhe***, University of Milan Bicocca, Italy; *Prasad Pofali,* Pravara Institute of Medical Sciences, India; *Amogh Vaidya,* University of Texas Southwestern Medical Center; *Uday Koli, Prajakta Dandekar, Rajendrasing Deshmukh, Ratnesh Jain,* Institute of Chemical Technology, India

The efficient intracellular delivery of nucleic acids remains limited by the lack of vectors that are both effective and biocompatible. In this study, we synthesized silver nanoparticles, that were surface-engineered using low-pressure pulsed RF plasma polymerization with acrylic acid in vapor phase to introduce carboxylic functionalities, followed by covalent coupling to chitosan oligosaccharide (COS) through EDC chemistry, yielding metallo-polymeric nanocarriers (MPNCs). Surface functionalization characterization confirmed successful functionalization: FTIR and XPS evidenced carboxylation and amide bond formation, while DLS showed an increase in hydrodynamic size from AgNPs to AgNPs/COOH (166.3±23.04 nm) and then to MPNCs with attached DNA (276.0±17.75 nm). Zeta potential shifted from negative values for AgNPs (-13.4±1.39 mV) to strongly positive values for MPNCs, supporting electrostatic complexation with plasmid DNA (27.0±1.1 mV). Gel retardation assays demonstrated stable nanoplex formation at a plasmid:MPNC ratio of 1:6, and the complexes remained stable across a broad pH range. Importantly, the MPNCs protected plasmid DNA against both DNase I degradation and sequence-specific restriction digestion. Cell viability assay demonstrated that the COS used to encapsulate the modified nanosilver using EDC (92.05±9.46% and 102.79±2.85%), was substantially less cytotoxic than bare AgNPs (0% and 0%), and AgNPs/COOH (0% and 0%) equivalent to Triton X-100 (positive control); MPNCs at 0.5 mg/ml (87.06±3.98% and 93.55±1.65%) maintained high viability in A549 and HeLa cells respectively. Cellular uptake studies (in-vitro) further showed that MPNC-bound plasmid-DNA was internalized efficiently, with GFP expression detected in A549 cells and quantified by flow cytometry, reaching about 10% transfection efficiency at 24 h. Overall, the work demonstrates that pulsed plasma surface functionalization, combined with COS conjugation, can transform silver nanoparticles into a stable, biocompatible, positively charged non-viral vector with meaningful gene delivery performance.

BI-ThP-6 UVC Surface Sterilization Comparative Study via a New, Rapid Handheld Bio-Sensor for Pathogens, InnovaBug™, using Macroscopic DNA/RNA Epi-Fluorescence On Calibrated *E.Coli* Cultures Vs Standard Plating, *Nicole Herbots,* Arizona State University Department of Physics/SiO2 Innovates LLC/InnovaBug LLC; *Archana Suresh, Adith Shankar,* SiO2 Innovates LLC/BacteroBug LLC/FungiBug LLC; *Ananya Suresh,* SiO2 Innovates LLC/BacteroBug LLC/InnovaBug LLC; *Manassa Suresh,* SiO2 Innovates LLC/BacteroBug LLC/FungiBug LLC; ***Viraj Amin***, *Zaid Abu-Salah, Nachiket Rajinikhant,* University of Missouri-Kansas City School of Medicine/SiO2 Innovates LLC/InnovaBug LLC; *Cara Jacobs,* University of Missouri-Kansas City/SiO2 Innovates LLC/InnovaBug LLC; *Eric J. Culbertson,* SiO2 Innovates LLC/InnovaBug LLC; *Robert J. Culbertson,* Arizona State University Department of Physics

Anti-Microbial Resistance kills 50,000 patients/y in the US, 1.3 Mil /y globally. Meanwhile, since 2009, new pathogens, epidemics, pandemics and global outbreaks occur about every 2.5 years, not every 8-year as measured since the 1800s. H1N1 (2009), MERS (2012), Ebola (2014), Zika (2015), Covid-19 (2019), mpox (2022), Ebola-causing Bundibugyo virus disease (BVD) (2026) – occurred in the last 17 years.

Two key strategies to address such crisis are prevention and detection, in other words, sanitation and sterilization as prevention, especially of surfaces, and rapid triage of infected patients as detection.

Standard sterilization methods such as autoclaving at 121 °C under high water steam pressure and gamma irradiation are not usable in public and hospital spaces. But an - as of yet unestablished - sterilization method, UVC, potentially is.

In this work, a methodology for sterilization via UVC irradiation, is investigated on two different model bacteria to establish which combinations of UVC irradiation dose can meet sterilization criteria.

Sterilization criteria require reducing the probability for a single viable microorganism to remain, to less than 10^{-6}, which is also defined as a Sterility Assurance Level (SAL) of 6.

UVC irradiation can eradicate pathogens by breaking bonds in nucleic acid pairs in DNA/RNA and is used in disinfection (SAL = 3). The present study investigates 260-280 nm LEDs to sterilize surfaces beyond disinfection (SAL=3) using as model bacteria *Lactobacillus Acidophilus* and *E.Coli*. to achieve full sterilization, or SAL 6.

The LEDs deliver a power density of 80 ± 0.04 μW/cm^2, at a distance of 1 cm. For reproducibility and accuracy, six identical sets of 10 cultures are tested, three of which are used for control and three of which are irradiated.

*E. Coli*CFU counts were calibrated to yield 20 ± 5 × 10^{9}typical for microbial cultures reproducibility. After serial dilution, A and B are inoculated. The three control sets are compared to three sets irradiated for 180 second at 1 cm on one half of the plate, while the other half is shielded to remain unirradiated. This is to verify that absence or limits on bacterial growth in the UVC irradiated area is indeed due to irradiation, not failed culturing.

Irradiation for 180 s. yields a total of 144 ± 7 mJ/cm^{2}on a 4 cm^{2}square area, and an average kill rate of 99.9999% on surfaces, with reproducibility achieved over 9 different plates.

In conclusion, UVC LEDs can consistently achieve sterilization with a SAL of 6. However, the timeframe for final sterilization may not be immediate, as measured within minutes with a new sensor, InnovaBug™, instead of after 48 hours culturing.

BI-ThP-7 Physics–Driven Mechanisms Governing the Pharmacokinetics and Immune Fate of Gold Nanoparticles: The ADIE Framework Perspective*,* ***Bashiru Sodipo****,* Kaduna State University, Nigeria*; Hafsah Oyedokun,* Kaduna University, Nigeria

The clinical translation of gold nanoparticles (GNPs) in nanomedicine hinges on a mechanistic understanding of their pharmacokinetics (PK) at the nano–bio interface. Traditional ADME (Absorption, Distribution, Metabolism, Elimination) model is effective for small molecules and biodegradable polymers. But it fails to capture the unique behaviour of inorganic GNPs, which are non-biodegradable, and not subject to enzymatic metabolism. Also, the interactions of GNPs in-vivo are not random biochemical processes. This Perspective introduces the ADIE (Absorption, Distribution, Immune interaction, and Elimination) framework. Immune interaction replaces metabolism as the pivotal phase. The journey of GNPs in-vivo is governed by transport physics and interfacial energetics. Convection and diffusion dictate distribution of the GNPs. While the collision of the nanoparticles with blood biomolecules and protein corona (PC) formation is governed by stochastic Brownian motion. The PC dictates immune recognition through competitive adsorption and thermodynamic binding energies. Also, it determines opsonization and clearance pathways. The elimination of GNPs is mainly via renal elimination. This is governed by size-exclusion physics and stealth coating (surface chemistry) property of the inorganic nanoparticles. While hepatic sequestration results from immune recognition. ADIE model offers a predictive foundation for designing GNPs with optimized biodistribution and clearance. Also, it advances the rational development of nanomedicines by integrating principles of transport physics, interfacial thermodynamics, and immune interaction.

BI-ThP-8 Rapid Solidification of Blood Drops Into Homogeneous Thin Films via Hyper-Hydrophilic Coatings: Electrolytes and Blood Iron Comparative Analysis by EXAFS, XRF and RBS*, Nicole Herbots, Yash Pershad,* ***Thilina Balassoriya****, Nikhil Suresh, Wesley Peng, Saaketh Narayan, Rianna Rane, Harshini Thinakaran, Ashwin Suresh,* Arizona State University Department of Physics/SiO2 Innovates LLC/MicroDrop Diagnostics LLC*; Arjun Sekar,* Arizona State University Department of Physics/SiO2 Innovates LLC/MicroDrop Diagnostics*; Aarush Thinakaran, Arya Saravanan,* Arizona State University Department of Physics/SiO2 Innovates LLC/MicroDrop Diagnostics LLC*; Robert J. Culbertson,* Arizona State University Department of Physics

The most common, initial test to diagnose a plethora of conditions – especially in ERs- is to test electrolytes and blood iron quickly so that the most common causes conditions such dehydration, hyponatremia, anemia, de-nutrition, etc can be assessed .. In 2026, 4 to 10 milliliters (mL) of blood are the standard Blood Volume (BV) required per test, with 10 mL being the most commonly sampled BV.

Drawing 3 to 8 vials is the norm, for a total of 30 to 80 mL blood per test. In hospitals, such tests are conducted **daily**. Iron anemia occurs when 10% of BV has been removed. It takes only 5 to 10 days to cause 75% of patients to incur Hospital-Acquired Anemia (HAA) In infants, it is standard practice to replace their ***entire*** blood volumes by continuous transfusion every 10 days.

Reducing BV can improve healthcare practices and outcomes.

HemaDrop™ is a ***Hyper-Hydrophilic*** coating that can rapidly solidify microliters (μL) sized blood droplets in minutes.

Hyper-Hydrophilicity (HH) can flatten droplets into flat films by rapidly absorbing H_2O, transforming liquid drops into Homogeneous Thin Solid Films (HTSF) without phase separation or segregation. Solidification via HH occurs no matter the temperature and relative humidity. By instantly flattening drops into thin liquid films with large areas of contact, HemaDrop™ does not rely on surface evaporation, unlike coagulation.

Inhibiting coagulation yields HTSF with smooth, glistening surfaces and uniform thickness unlike the rough surfaces and uneven thickness of conventional Dried Blood Spots (DBS). 0.05 mL or 50 μL of blood yields HTSF of uniform composition to ±10% over ~0.25 cm^2, or 5 mm diameter blood disks.

Rapid solidification of blood drops via HH allows for solid state analysis in minutes via hand-held X-ray Fluorescence (XRF) while the BV drawn is reduced to 0.1 mL

Three independent methods were used to test this proposition.

Rutherford Backscattering Spectrometry (RBS) is used to study lateral uniformity, absolute elemental composition. compositional depth profile, and comparison to DBS.

X-ray Fluorescence (XRF) measured relative elemental composition of the blood HTSF

Extended X-ray Absorption Fine Structures (EXAFS) was used to detect blood iron to p.p.b.. EXAFS spectra show consistent, reproducible detection iron in multiple HTSFs of the same blood.

Accuracy and reproducibility of Solid State Analysis of Blood HTSFs via RBS, XRF, and EXAFS were tested by measuring electrolytes (Na, K, Mg, Ca, Cl) and Fe from single 50- μL droplets. Relative error analysis for XRF, RBS and EXAFS measured on multiple HTSFs shows reproducibility within 10%, the medically accepted standard.

BI-ThP-9 Rapid Differential Detection & Triage of Bacterial, Viral & Fungal Infection Triage for Early Outbreak Containment via Differential Macroscopic DNA/RNA Epi-Fluorescence (DMEF) in a Small Fluid Volume Diagnostic (SFVD) handheld Device: MicrobeD™**, Nicole Herbots,* Arizona State University Department of Physics/SiO2 Innovates LLC/InnovaBug LLC*; David Guo,* Drexel University School of Medicine/SiO2 Innovates LLC/InnovaBug LLC/ViroBug LLC*; Arya Saravanan,* Arizona State University School of Health Sciences/SiO2 Innovates LLC/BacteroBug LLC/MicrobeD LLC*; Nithish Prakash,* University of Pennsylvania School of Medicine/SiO2 Innovates LLC/InnovaBug LLC/ViroBug LLC/MicrobeD LLC/*; Manassa Suresh,* SiO2 Innovates LLC/InnovaBug LLC/MicrobeD LLC*; Jonathan Guo,* SiO2 Innovates LLC/InnovaBug LLC/ViroBug LL/MicrobeD LLC*; Nila Kathivaran,* Arizona State University Department of Physics/SiO2 Innovates LLC/BacteroBug LLC/MicrobeD LLC*; Sudharshini (Sudhi) Ram,* Arizona State University Department of Physics/InnovaBug LLC/ViroBug LLC/MicrobeD LLC/AID-TRIAGE LLC*; Ananya Suresh,* Arizona State University Department of Physics/SIO2 Innovates LLC/BacteroBug™/MicrobeD LLC*; Archana Suresh,* Arizona State University Department of Physics/SiO2 Innovates LLC/BacteroBug LLC/MicrobeD LLC*; Adith Shankar,* Arizona State University Department of Physics/SiO2 Innovates LLC/innovaBug LLC/MicrobeD LLC*; Esther Guo,* Arizona State University Department of Physics/SiO2 Innovates LLC/Innovabug LLC/ViroBug LLC/MicrobeD LLC*; Sriram Rajesh, Edawrd Kelemen,* Arizona State University Department of Physics/SiO2 Innovates LLC/InnovaBug LLC/BacteroBug LLC/MicrobeD LLC

In the years 2000-2026, **ten** viraloutbreaks have arisen, **four from new viruses**: West Nile (2003), **SARS-Cov-1 (2002-04),H1N1/Swine flu (2009-10), MERS-CoV (2012)**, Zaire Ebola virus (2013-2016), Zika (2015-2016), **COVID-19 (2019-21),**mpox (2022), Ebola-causing Bundibugyo Virus (BVD) (4/24/2026-), Andes Hantavirus, (5/9/2026-), thus one outbreak per 2.6 years, in contrast to an average of 1 per 8.5 years between 1800 and 2000.

Current diagnostics for viral infections use polymerase chain reaction (PCR) and virus-specific antigens. Covid-19 PCR swabs yield 40 % False Negatives (FN), 50% False Positives (FP) in the first 7 days of infection and need 3 days and advanced lab equipment for results. Covid-19 Rapid Antigen tests yield 66% FN and 40% FP in asymptomatic individuals.

Rapid, reliable detection of viruses is needed early in outbreaks until virus-specific tests are available. Two months into the 2026 Ebola BVD outbreak, **no** BVD tests exist. OTC COVID-19 became widely available only on Dec. 15, 2020, 12 months on.

Here, a new approach for detection and triage, *Differential Macroscopic DNA/RNA epi-fluorescence (DMEF),* uses test strips inserted a single hand-held, 'Small Fluid Volume Diagnostic' (SFVD) device, MicrobeD™*, akin to a blood glucose meter, but designed as an accessory to attached to a Smartphone camera. Test strips - called InnovaBug™*, with design subcategories specified as BacteroBug™*for bacteria , ViroBug™* for

viruses, and FungiBug™ for fungi, are optimized to detect and differentiate in minutes viral infections and loads from bacterial ones, use pairs of 0.015 mL drops, and aim for an accuracy ≤ 10% for FN and FP, 10% being the medical gold standard.

Strips combine DMEF from different dyes.

Micro-filters integrated to the strips impregnate blood serum, urine, sputum, etc .. with safe DNA/RNA fluorophores.

The strips are inserted into MicrobeD™, where the smartphone camera captures irradiances: $I_B$of LEDs inducing fluorescence, and fluorescence irradiances, $I_F$from DNA and RNA. Net $I_F$are analyzed via an AI App, AID-TRIAGE™*, which normalizes $I_{F\ with} I_B$, as a $R_{F/B}$ratio. AID-TRAIGE™ matches $R_{F/B}$to pathogen type and load via calibration tables from plating and assays databases. Sensitivity spans $10^5$to 10^9CFUs/mL, test duration ~ 5 -20 min. DMEF was collected on 500 InnovaBug™ strips, in 4 labs disseminated in Phoenix Metro, via 12 studies over 2 years with 4 MicrobeD™ prototypes. Manual analysis and AID-Triage™ established proof-of-concept, accuracy & reproducibility of DMEF to detect and differentiate pathogen types and loads via*in vitro*diagnostic device, MicrobeD™, InnovaBug™* test strips and the AID-Triage™ App.

* Patents Pending (2026)

BI-ThP-10 Decoding Antifouling Failure: How Primary Microfouling Communities Compromise Biocide Release*, **Kailey Richard,*** National Research Council Research Associateship Program at US Naval Research Laboratory*; Kenan Fears,* Naval Research Laboratory

For decades, copper-based marine coatings have been the primary defense against biofouling. However, their failure, suspected to be caused by microbial copper tolerance, is a growing concern. Primary colonizers, like bacteria and diatoms, can develop resistance, forming biofilms that may slow biocide release and accelerate macrofouling. This study investigates the role of key fouling species in this process, with a focus on diatoms. To achieve this, we exposed *Navicula incerta* and the green alga *Enteromorpha* sp. to copper biocides, copper (II) ions and copper (II) pyrithione, to assess their level of tolerance, their influence on the biocides chemical state, and their impact on copper release rates. Furthermore, this study investigates the interactions between bacterial and diatom communities, by establishing bacterial biofilms on coatings prior to the introduction of diatoms to observe the effects on subsequent diatom adhesion and growth.

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