**Session Proposal**

# Session Title

Roles of extracellular polymeric substances in biogeochemical cycling and soil health

# Session Organizers

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# Session Description

Extracellular Polymeric Substances (EPS) are high-molecular-weight organics secreted by microorganisms into their environment. These substances play a pivotal role in soil ecosystems by influencing biogeochemical cycling and modifying soil physicochemical properties. This session aims to explore the multifaceted functions of EPS in soil environments, including their impacts on nutrient dynamics, pollutant transformation, organic matter stabilization, soil aggregation, and water retention. We invite contributions that delve into the methodological advancements in EPS characterization, molecular composition of EPS, interactions between EPS and soil minerals, their role in mediating microbial community dynamics, soil health, and ecosystem sustainability. Furthermore, a hands-on workshop will provide practical training on EPS extraction, quantification, and the assessment of carbon use efficiency (CUE) in EPS production using isotopic techniques. This session seeks to bring together researchers from soil biochemistry, soil microbiology, and microbial ecology and foster a comprehensive understanding of EPS as central agents of soil function and resilience.

# Format

Oral presentations, workshops

# Proposed Speakers

Hans-Curt Flemming, former director and honorary professor of the Biofilm Center at the University of Duisburg-Essen, visiting professor at Nanyang Technological University, Singapore, and the National Center for Environmental Life Sciences and Engineering, Singapore, and currently a distinguished researcher at the Institute of Oceanology, Chinese Academy of Sciences (His research focuses on the biological characteristics of biofilms, antifouling strategies, and the application of EPS. He proposed the concept of "interference threshold", advocated eco-friendly antifouling, revealed the dual role of EPS in environmental remediation and medicine, and integrated interdisciplinary methods to solve biofilm problems in the industrial and medical fields. Professor Flemming uses high-resolution microscopy (CLSM, AFM), molecular analysis (ITS melting curve, transcriptomics), chemical characterization (FTIR, XPS) and other technologies to reveal the dynamics and functions of biofilms and EPS matrices.He has been engaged in biofilm and EPS research for more than 30 years. He is one of the pioneers of biofilm research in Germany. He founded the Biofilm Center at the University of Duisburg-Essen in Germany and published more than 300 academic papers, with more than 10,000 citations per paper.)

Arunima Bhattacharjee, a researcher in the Environmental Molecular Sciences Division at the Pacific Northwest National Laboratory, USA. (Her research focuses on the ecological functions of soil microbial EPS under environmental stress and their impact on carbon cycling, with a particular emphasis on the relationship between the chemical properties of microbial EPS and water retention under drought conditions. By integrating microfluidic soil micromodels with fluorescence lifetime imaging microscopy (FLIM) and mass spectrometry imaging (MALDI-MSI), she has revealed the mechanisms of water retention by EPS at the pore scale. In addition, she has developed platforms such as the SoilBox and mineral-doped micromodels, combining multimodal imaging with omics technologies to investigate transmembrane nutrient transport by fungal hyphae and spatially heterogeneous metabolic processes. Her work provides innovative approaches for studying microbe–mineral interactions and soil carbon stability under climate change. Arunima Bhattacharjee has published over 20 research articles in international journals including *Annual Review of Environment and Resources*, *Soil Biology and Biochemistry*, and *ACS Applied Materials & Interfaces*. She is also a recipient of the Schlumberger Foundation Faculty for the Future Fellowship.)

Chao Liang, Chinese Academy of Sciences (a leading expert in microbial ecology and soil biogeochemistry, particularly how microbial processes influence soil organic matter sequestration and ecosystem functions. His research integrates microbiology, organic chemistry, and modeling to examine microbe-mediated biogeochemical processes. Dr. Liang has received several honors, including the Humboldt Research Fellowship from the Alexander von Humboldt Foundation.)

Christopher R. Anderton, Research Scientist in the Earth and Biological Sciences Directorate at Pacific Northwest National Laboratory (PNNL). (His research expertise includes spatial metabolomics, mass spectrometry imaging technologies, and the study of soil microbial processes and their environmental responses. Dr. Anderton focuses on developing high-resolution mass spectrometry imaging methods to systematically investigate the dynamics of EPS formation in soils and rhizosphere environments, and their responses to carbon source accessibility. His work integrates microscale imaging with ecological process analysis to reveal how the chemical characteristics of microbial communities influence soil structural stability and microbial ecosystem resilience.)

Cordula Vogel, Institute of Soil Science and Site Ecology, Technische Universität Dresden (Her research focuses on understanding biogeochemical processes in soils across various spatial scales, from microscopic to landscape levels. Key areas of her work include soil organic carbon dynamics, the role of EPS in soil structure and stability, and the interactions between enzymes and mineral phases. Dr. Vogel employs advanced visualization techniques, such as environmental scanning electron microscopy (ESEM), to investigate soil structure and nutrient cycles. She has received several accolades for her contributions to soil science, including the Dr. Heinrich-Baur-Förderpreis and the doctoral award from the Bund der Freunde der TU München.)

Eiko Eurya Kuramae, a senior scientist at the Netherlands Institute of Ecology (NIOO-KNAW) and a professor of microbial community ecology and environmental genomics at Utrecht University (Her research focuses on revealing the taxonomic and functional interactions within soil microbial communities, and also focuses on the ecological functions of EPS and the impact on soil aggregates. Her main research areas include the impact of land use and global climate change. To achieve these goals, she uses cutting-edge tools in omics methods, bioinformatics, multivariate statistics and modeling. By studying microbial taxonomy and functional interactions, she predicts the consequences of various changes, including those related to land use, sustainable agriculture and cropping systems. Professor Kuramae has published more than 100 papers in international journals such as *Nature Communications*, *Science of the Total Environment*, *Soil Biology and Biochemistry*, among which EPS-related articles have more than 1,000 citations per paper. She is currently a member of the editorial board of journals such as ISMEJ and Microorganisms.)

Folasade K. Olagoke, Postdoctoral Researcher at the Chair of Soil Resources and Land Use, Institute of Soil Science and Site Ecology, Technische Universität Dresden, Germany (Her research expertise includes soil microbial ecology, EPS production, soil enzyme activities, and soil aggregate stability. Dr. Olagoke focuses on the interactions between microbial extracellular enzymes and soil minerals, investigating how these interactions influence soil organic matter decomposition and carbon cycling. She combines field experiments with laboratory analyses to explore how mineral composition affects enzyme persistence and soil structural stability. Her work contributes to advancing the understanding of soil microbial processes in maintaining soil health and promoting sustainable land management.)

Laurent K. Kidinda, Researcher at the Chair of Soil Resources and Land Use, Institute of Soil Science and Site Ecology, Technische Universität Dresden, Germany, and at the Biogeochemistry and Ecology of Tropical Soils and Ecosystems Group, University of Lubumbashi, Democratic Republic of the Congo (His research expertise lies in soil biogeochemistry, tropical soil management, microbial ecology, and environmental sustainability. Dr. Kidinda primarily focuses on the production of microbial EPS and their relationships with land cover change, microbial community structure, and enzyme activity in tropical soils. He integrates field investigations with laboratory analyses to elucidate the interactions between soil minerals, organic matter, and microbial activity. His work advances the understanding of soil structure development, nutrient cycling, and sustainable land management in tropical ecosystems.)

Leslie M. Shor, Professor in the Department of Chemical and Biomolecular Engineering and the Center for Environmental Sciences & Engineering, Vice Provost for Graduate Education, and Dean of the Graduate School at the University of Connecticut (UConn) (Her research expertise includes microbial systems engineering, agricultural biotechnology, environmental biotechnology, and microfluidics and BioMEMS. Dr. Shor leads the Engineered Microhabitats Research Group, systematically investigating the behavior and interactions of microbial communities within complex microstructured environments, with a particular focus on the generation mechanisms and ecological functions of EPS under microscale environmental dynamics. Her research has important applications in sustainable agriculture, environmental remediation, biofuel production, and medicine, particularly in elucidating how EPS-driven processes contribute to soil structural stability and microbial ecological adaptation to environmental changes. She is a recipient of the DuPont Young Professor Award, a finalist for the Connecticut Women of Innovation Award, and a participant in the National Academy of Engineering Frontiers of Engineering Education symposium.)

Roberto De Philippis, an Associate Professor in the Department of Agriculture, Food, Environment and Forestry at the University of Florence, Italy. (His research focuses on the applications of cyanobacteria and microbial EPS in ecological restoration and biotechnology. By systematically investigating the mechanisms by which cyanobacteria induce the formation of biological soil crusts, he explores the use of their EPS to improve soil structure, water retention, and fertility, contributing to desertification control. He also studies the ecological functions of microbial communities in extreme environments. With regard to the bioactivity of EPS, his research deciphers their chemical composition and molecular properties, aiming to develop their potential applications in heavy metal adsorption, wastewater treatment, and anticancer drug development. His work integrates molecular biology approaches with materials characterization techniques, and includes field trials to evaluate the long-term effects of cyanobacterial inoculation on soil restoration. This promotes the transition from laboratory research to real-world environmental applications. His innovative contributions support sustainable ecological management and clean energy development. He has published more than 180 papers in international journals.)

Yian Gu, Nanjing Tech University (Prof. Gu’s research notably focuses on plant-microbe interactions, exploring the complex relationships between plants and their microbial environments. His work contributes valuable insights to understanding and improving agricultural practices and environmental sustainability, as evidenced by his publications in respected scientific journals including *Science Advances* and *The ISME journal*.)

Anxu Sheng, Huazhong University of Science and Technology (Dr. Sheng’s research focuses on environmental chemistry and geochemistry, with particular emphasis on the transformation and behavior of iron (oxyhydr)oxides and their interactions with organic and inorganic contaminants. Dr. Sheng has authored a number of publications in esteemed journals like EST and GCA, contributing significantly to the understanding of nanoparticle aggregation, adsorption kinetics, and the environmental implications of iron minerals. His work employs advanced techniques, such as in situ liquid cell transmission electron microscopy, to elucidate the mechanisms governing mineral transformations and their environmental impacts.)