CENTER FOR HYBRID, ACTIVE, AND RESPONSIVE MATERIALS

CHARM

at the UNIVERSITY OF DELAWARE

Soft matter CRiSP Polymers

MACROMOLECULAR DESIGN & SYNTHESIS · FABRICATION & PROCESSING · METROLOGY & INSTRUMENT DEVELOPMENT · THEORY & SIMULATION

JAN VERMANT
Eidgenössische Technische Hochschule Zürich (ETH)
Professor

THURSDAY, JUNE 8, 2023
2:00 PM IN 102 COLBURN LAB

ENGINEERING SUSTAINABLE MULTIPHASE SYSTEMS

ABSTRACT

Stable foams or emulsions that can resist disproportionation for extended periods of time have important applications in a wide range of technological and consumer materials. Yet, legislative initiatives limit the range of surface active materials that can be used, for environmental impact reasons. There is a need for technologies to efficiently produce multiphase materials using more eco-friendly components, such as particles, and for which traditional thermodynamics-based processing routes are not necessarily efficient enough. In this talk I will first discuss how the relationship between the structure and properties of these interfaces warrants a deeper look and forces us to think about the rheological modelling of these interfaces, with properties ranging from 2D fluids to (surprisingly) auxetic solids. The second aspect relates to novel startegies to produce ultrastable Pickering-Ramsden foams, with bubbles of micrometer-sized dimensions, through pressure-induced particle densification. Specifically, aqueous nanosilica-stabilized foams are produced by foaming a suspension at sub-atmospheric pressures, allowing for adsorption of the particles onto large bubbles. This is followed by an increase back to atmospheric pressure, which induces bubble shrinkage and compresses the adsorbed particle interface, forming a strong elasto-plastic network that provides mechanical resistance against disproportionation. The foam's interfacial mechanical properties are quantified to predict the range of processing conditions needed to produce permanently stable foams, and a general stability criterion is derived by considering the interfacial rheological properties under slow, unidirectional compression. Foams that are stable against disproportionation are characterized by interfaces whose mechanical resistance to compressive deformations can withstand their tendency to minimize the interfacial stress by reducing their surface area. Our ultrastable nanosilica foams are tested in real-life applications by introducing them into concrete, as an enviromentaly friendly air entrainer. The applicability of our stability criterion to other rheologically complex interfaces and the versatile nature of our foaming technology enables usage for a broad class of materials, beyond the construction industry.

BIOGRAPHY

Jan Vermant studied Chemical Engineering at KU Leuven in Belgium, obtaining the doctoral degree in 1996 under the supervision of Prof. Jan Mewis. He was a postdoctoral fellow of Elf Aquitaine and the Fund for Scientific Research – Vlaanderen at Stanford University and at the CNRS. In 2000 he joined the faculty at the department of Chemical Engineering at KU Leuven, becoming a full professor in 2005. In 2014 he joined the Materials Department at the ETH Zürich where he now heads the laboratory of Soft Materials. He has held visiting appointments at Stanford University (USA), University of Delaware (USA), Princeton University (USA), the Forschungszentrum Jülich (G) and the ESPCI (F). His research at the ETH Zürch focuses on the rheology and applications of complex fluid-fluid interfaces, colloidal suspensions and the development of novel experimental methods and soft matter applications in materials science.

UNIVERSITY OF DELAWARE
ENGINEERING