Aalto University
School of Chemical Engineering

https://www.aalto.fi/school-of-chemical-engineering
https://into.aalto.fi/display/endoctoralchem
puh. 050 577 3736 Sirje Liukko

Defence announcement Public Defence on 10 June 2024

Interfacial Adsorption and Stabilization of Nanopolysaccharides in Multifunctional Emulsion Systems

Title of the doctoral thesis	Interfacial Adsorption and Stabilization of Nanopolysaccharides in Multifunctional Emulsion Systems
Content of the doctoral thesis	This thesis explores the roles of biobased polysaccharide nanoparticles, including cellulose nanofibrils (CNF), cellulose II nanospheres (NPcats) and chitin nanofibrils (NCh), as stabilizers of emulsion systems. We demonstrate the potential application of these emulsions in the development of advanced materials. The thesis discusses phenomena relevant to colloidal behaviors and adsorption of nanopolysaccharides at oil/water and water/water interfaces, in the form of Pickering emulsions. Variables relevant to the emulsion behaviors, including the particle's interfacial wetting properties, hydrophilicity, functional groups, electrostatic charge, axial aspect ratio and entanglement were evaluated by complementary characterization platforms. The complexation of two oppositely charged nanopolysaccharides, CNF and NCh, were demonstrated to effectively stabilize oil-in-water Pickering emulsions with adjustable droplet size and stability against creaming and oiling-off, imparting long-term stability and remarkable environmental tolerance. Likewise, driven by electrostatic interactions, tuning the mass and charge ratio of NPcat and bovine serum albumin (BSA), the formation of a soft and dense NPcat/BSA layer, is shown to enable the formation of dense NPcat/BSA interfacial layers, stabilizing water-in-water emulsions. Furthermore, NCh was used to formulate high internal phase Pickering emulsions (HIPPEs) through pre-emulsification followed by continuous oil feeding that facilitated a "scaffold" with high elasticity, which arrested droplet mobility and coarsening, achieving edible oil-in-water emulsions with a high internal phase volume fraction (as high as 88%). These green Pickering emulsions offer potential in applications relevant to foodstuff, pharmaceutical, and cosmetic formulations. Direct ink writing (DIW) was applied as a platform to engineer biobased Pickering emulsions to extend their applications. The HIPPEs were easily textured by leveraging their elastic behavior and resilience to compositional changes, making them suitable for 3D printing edible functional foods via DIW. Additionally, we structured emulsion stabilized by NCh (50% oil fraction) through one-step processing into hierarchically and spatially controlled porous structures defined by emulsion droplet size, ice templating, and DIW infill density. The obtained scaffolds are demonstrated for their excellent modulation of cell adhesion, proliferation, and differentiation, as tested with mouse dermal fibroblast expressing green fluorescent proteins. Taken together, the findings in this thesis are of interest in developing and understanding fundamental emulsion stabilization mechanisms and advancing practical applications. The obtained green Pickering emulsion systems are expected to have an important role in food emulsions, encapsulation, pharmaceuticals, (bio)catalysis, and advanced synthetic cell mimetics.
Field of the doctoral thesis	Bioproduct Technology
Doctoral candidate and contact information	M.Sc. (Tech.) Ya Zhu ya.zhu@aalto.fi
Public defence date and time	10 June 2024 at 4 PM Helsinki time - 2PM London time - 9PM Beijing time - 6AM Vancouver time
Remote defence	https://aalto.zoom.us/j/64373796211
Opponent(s)	Professor Koon-Yang Lee, Imperial College of London, UK
Custos	Professor Orlando Rojas, Aalto University School of Chemical Engineering

Dissertation will be on public display at https://aaltodoc.aalto.fi/doc_public/eonly/riiputus/

Aalto University
School of Chemical Engineering

https://www.aalto.fi/school-of-chemical-engineering
https://into.aalto.fi/display/endoctoralchem
puh. 050 577 3736 Sirje Liukko

Link to electronic thesis https://aaltodoc.aalto.fi/items/dd69ccf2-3d63-4b22-b340-efc856f8b9ac

Keywords Cellulose, Chitin, Pickering emulsion, Interfacial adsorption, Direct ink writing