Coalescence in Pickering emulsions: influence of deacetylation of chitin nanoparticles and dispersed phase fraction investigated by microfluidic techniques

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Chitin nanoparticles (ChNPs), derived from renewable biopolymers, are promising Pickering stabilizers due to their biocompatibility and tunable surface properties. Pickering emulsions are known for their long-term stability compared to conventional emulsifiers. However, the role of particles in early droplet stabilization remains poorly understood, as in large-scale emulsification, droplet formation and coalescence occur at the same time. In this study, we used a **microfluidic T-junction device** in which we could de-couple the formation and coalescence processes at short time-scales. We varied the surface composition of ChNPs by deacetylating and testing them at low (~10%) and high (>50%) dispersed phase fractions (ϕ) to monitor droplet coalescence.

We show that the treatement of **deacetylation reduced droplet coalescence,** likely due to improved particle adsorption and an increase in zeta potential from +29.9 mV to +43.1 mV. In addition, **higher dispersed phase fractions led to prolonged droplet interaction times and contact frequency** (*e.g* ., at ϕ = 0.55, some droplets interacted in pairs, while at ϕ = 0.75, as many as five surrounding droplets were observed), thus enhancing coalescence. Overall, our findings demonstrate how particle surface properties and dispersed phase fraction together determine interfacial coverage and coalescence resistance, which provides mechanistic insights for the critical design of robust biobased Pickering emulsions.

Keywords:
Pickering emulsions, chitin nanoparticles, microfluidics, droplet coalescence, particle adsorption

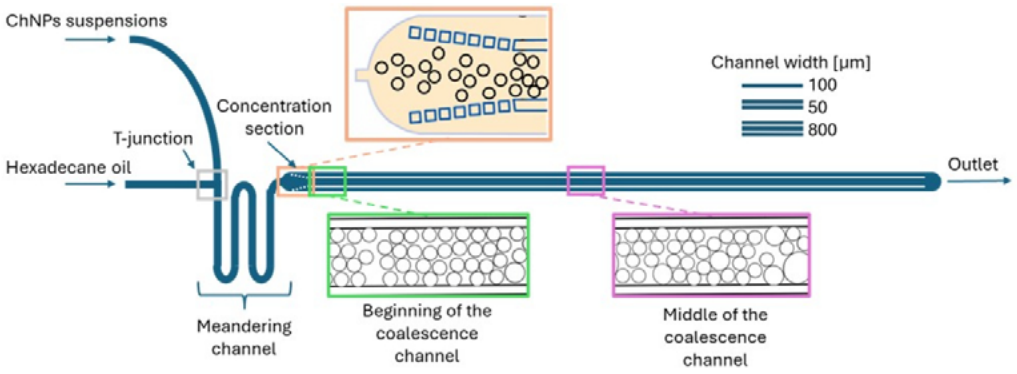

Fig. 1. Layout of the microfluidic chip with four sections: a T-junction, a meandering channel (after the T-junction), a concentration section, and a coalescence channel in which at various positions observations can be done. The channel height is 45 µm throughout the chip.

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