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Coalescence stability of Pickering emulsions produced with lipid particles: A microfluidic study

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Abstract

In the quest to find approaches to prepare food grade Pickering emulsions, we studied the formation and stability to coalescence of colloidal lipid particle (CLP)-stabilized emulsions within a cross-flow microfluidic device. We show that the particles can either stabilize or destabilize the emulsions depending on the particle adsorption rate versus droplet formation rate, and on the resulting surface coverage when the droplet is formed. At low surface coverage, when droplet formation is significantly faster than adsorption, CLPs have a destabilizing effect as incomplete surface coverage leads to droplet-droplet bridging. At high surface coverage, the dense particle layer results in an effective barrier against droplet coalescence, resulting in physically stable emulsions. The observed non-monotonic dependency of emulsion droplet stability on surface coverage of CLP-stabilized emulsions is in stark contrast to what is observed for conventional surfactant-stabilized emulsions, and thus should be taken into account for the rational design of Pickering emulsions.

1. Introduction

In recent years, biocompatible and food-grade particles have raised a lot of interest for the application as emulsion stabilizers (Rayner et al., 2014). Moreover, these days there has been considerable empirical evidence that suitable Pickering particles exist in nature, can be purposely manufactured, or even have already been used unintentionally such as in mayonnaise (Binks, 2007; Firoozmand and Rousseau, 2016; Gould et al., 2013; Luo et al., 2011; Pawlik et al., 2016). For oil-in-water (O/W) emulsions, most reported particles are based on proteins (de Folter et al., 2012; Liu and Tang, 2013) or polysaccharides (Mikulcová et al., 2016; Rayner et al., 2012; Timgren et al., 2013; Yusoff and Murray, 2011). Recently, we have shown that colloidal lipid particles (CLPs) can be used as Pickering stabilizers in O/W emulsions, leading to remarkable physical stability compared to conventional emulsifiers (Schröder et al., 2017). CLPs are especially promising as they are simple to