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RESEARCH ARTICLE

Effects of fiber wettability and size on droplet detachment residue

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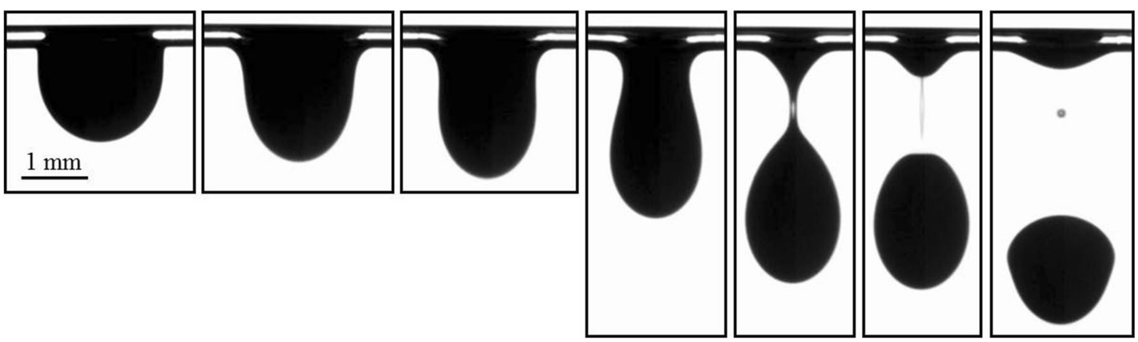
Abstract

This paper reports on an experimental study devised to better our understanding of the role of Young–Laplace contact angle (YLCA), fiber diameter, fluid viscosity, or droplet size on the volume of droplet residue left on a fiber after droplet detachment. This was made possible using an aqueous ferrofluid droplet deposited on a horizontal filament in a controllable magnetic field. Droplet detachment process was imaged using a high-speed camera and the images were used to obtain residue volume and droplet detachment time. It was found that residue volume decreases with increasing filament's YLCA or droplet viscosity (in a viscosity range of 1–5.5 mPa s), but it increases with increasing fiber diameter or remains unchanged when increasing droplet volume. Droplet detachment time was found to increase with droplet volume or fiber diameter but remained unaffected by increasing droplet viscosity from 1 to 5.5 mPa s. In addition, droplet detachment time was found to decrease with increasing YLCA of the fiber.

Graphical abstract



1 Introduction

Interactions between a droplet and a fiber or a fiber-like structure has received considerable attention from the engineering community for its importance in many new or existing industrial applications. Examples of such applications include, but are not limited to, fog harvesting (Seo et al. 2016; Shi et al. 2018), droplet filtration from gaseous streams, e.g., engine exhaust (Kampa et al. 2014; Muller et al. 2014; Wurster et al. 2015; Wei et al. 2018) or droplet–fluid separation, e.g., water droplet removal from fuels (Contal et al. 2004; Patel and Chase 2014; Rajgarhia et al. 2016), textiles and apparel (Michielsen and Lee 2007; Chen et al. 2010), microfluidics (Gilet et al. 2009; Reznik et al.

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