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Research Paper

Modelling droplet sliding angle on hydrophobic wire screens

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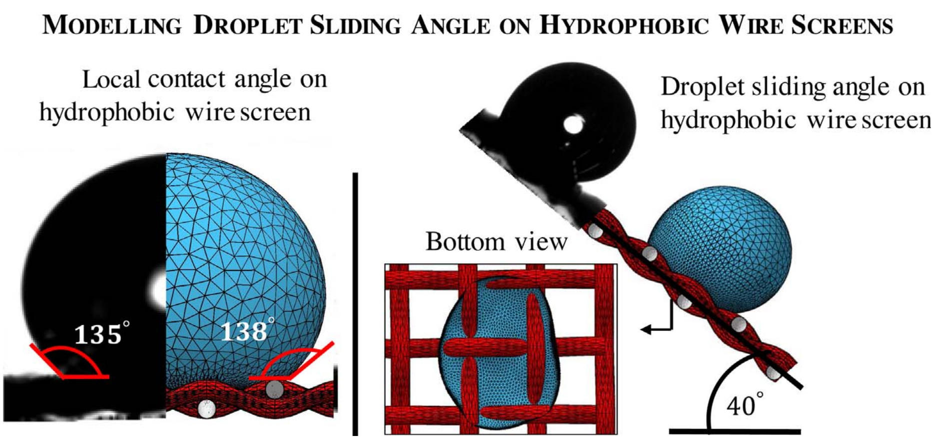
GRAPHICAL ABSTRACT



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ABSTRACT

This work presents a detailed investigation of the droplet lower and upper contact angles on hydrophobic wire screens with different properties such as wire diameter, wire spacing, or Young–Laplace contact angle. Numerical simulation and experiment were considered to better our understanding of the factors impacting droplet sliding on a hydrophobic screen, and to quantify their importance. To conduct the numerical simulations, the screens' geometry was programed in the Surface Evolver code, and the droplet shape was obtained by minimizing the total energy of the droplet–screen system iteratively using the code's finite element solver. Good general agreement was observed between the results of our numerical simulations and experimental data. Most interestingly, it was observed that droplet sliding angle increases with increasing the wire spacing in screens with a given wire diameter. To explain this counterintuitive observation, detailed quantitative information is presented in terms of the three-phase contact line on the droplet's receding side as well as the penetration of the air–water interface into the void space between the wires. The results of our study are discussed in the context of the contemporary literature.

1. Introduction

Wire screens treated with a hydrophobic coating have become a cost-effective way of creating a porous water repellent (or oil repellent if treated with an oleophobic coating) surface. Such porous structures have been considered for a variety of potential applications such as drag reduction on submerged surfaces [1–5], oil–water separation [6–11], heat transfer or anti-icing [12–14], self-cleaning [15–17], and fog

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