

Simulation of droplets on a spider silk with various wetting conditions and geometries

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Many biological surfaces have special structures to control their interaction with water. Spider web also has significant fiber structure that can collect drops on the wetted spider silk as they condensate. To understand the dynamics of the phenomenon, we simulated the droplets on fiber with COMSOL Multiphysics using level-set method.

The fiber is divided into two different regions. The hydrophilic region is at the middle of the fiber and the hydrophobic regions are at each side of the fiber. The water condensation occurs in the hydrophobic region. When the droplets become large enough to overcome the hysteresis effects, we can see the movement of the droplets dynamically.

In this simulation, as water condensation is continued, small water droplets get bigger. As they reach the hydrophilic region, they start moving to each other by difference of Laplace pressure and coalesce. In addition, we considered the effect of different fiber geometries. The droplets on a spindle-shaped fiber move more easily than those on a straight fiber.

The study about the droplet coalescence of a fiber will be helpful to many applications such as fibrous filter systems.