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Biphilic Surfaces for Enhanced Water Collection from Humid Air[1] JASON BENKOSKI, KONSTANTINOS GERASOPOULOS, WILLIAM LUEDEMAN, Johns Hopkins University APL — Surface wettability plays an important role in water recovery, distillation, dehumidification, and heat transfer. The efficiency of each process depends on the rate of droplet nucleation, droplet growth, and mass transfer. Unfortunately, hydrophilic surfaces are good at nucleation but poor at shedding. Hydrophobic surfaces are the reverse. Many plants and animals overcome this tradeoff through biphilic surfaces with patterned wettability. For example, the Stenocara beetle uses hydrophilic patches on a superhydrophobic background to collect fog from air. Cribellate spiders similarly collect fog on their webs through periodic spindle-knot structures. In this study, we investigate the effects of wettability patterns on the rate of water collection from humid air. The steady state rate of water collection per unit area is measured as a function of undercooling, angle of inclination, water contact angle, hydrophilic patch size, patch spacing, area fraction, and patch height relative to the hydrophobic background. We then model each pattern by comparing the potential and kinetic energy of a droplet as it rolls downwards at a fixed angle. The results indicate that the design rules for collecting fog differ from those for condensation from humid air.

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