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Moisture-driven actuators inspired by motility of plants
BEOMJUNE SHIN, MINHEE LEE, HO-YOUNG KIM, Seoul National University
— We report design and fabrication of moisture-driven actuators mimicking pine cones, wild wheats and seeds of Erodium cicutarium, which can bend and even helically coil with variation of environmental humidity. The actuators adopt a bilayer configuration, one of whose layers is hygroscopically active while the other is inactive. In order to enhance the degree and speed of deformation which critically depends on moisture-responsivity of the active layer, nanofibers of hydrogel are directionally deposited on the inactive layer via electrospinning. As a result, several designs of soft robots are demonstrated which are capable of locomotion by harvesting environmental humidity energy. The dynamics of the robots are analyzed by coupling moisture diffusion kinetics and elastic theory of multi-layer bending. The theoretical predictions are compared with the experimental results, to lead to the optimal design to maximize the locomotion speed measured by travel distance normalized by body length per unit time.

Ho-Young Kim
Seoul National University

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