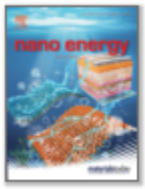
Nano Energy
Volume 56, February 2019, Pages 759-769



Self-organized and self-propelled aero-GaN with dual hydrophilic-hydrophobic behaviour

Ion Tiginyanu, Tudor Braniste, Daria Smazna, Mao Deng, Fabian Schütt, Arnim Schuchardt, Marion A. Stevens-Kalceff, Simion Raevschi, Ulrich Schürmann, Lorenz Kienle, Nicola M. Pugno, Yogendra Kumar Mishra, Rainer Adelung

https://doi.org/10.1016/j.nanoen.2018.11.049

Abstract

Nature utilizes hydrophilic-hydrophobic biomolecular entities to perform self-organized structural and functional tasks, including the formation of cellular compartments and motion, separation of chemicals or self-healing properties in a highly energy efficient manner. So far, no inorganic artificial micro/nanostructure units are known that self-organize and mimic such functions just by adding liquid. Here we develop the first nanomaterial exhibiting hydrophobic wetting and hydrophilic dewetting. Consisting of gallium nitride nanoscopically thin membranes shaped as hollow microtetrapods, which we term aerogalnite (AGaN), the nanomaterial is extremely porous, mechanically flexible, stretchable, and exhibits hydrophilicity under tension and hydrophobicity when compressed against water. Self-assembling the AGaN tetrapods on water enabled us to develop self-healing waterproof rafts carrying liquid droplets 500-times as heavy as rafts, and to demonstrate self-propelled liquid marbles exhibiting velocity of rotation as high as 750 rot/min. The specific force of the detachment of AGaN from the water surface was experimentally determined equal to 35 mN/cm2. The new developed material aerogalnite and its peculiar characteristics are promising for applications in sensorics, microfluidic devices and microrobotics.