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Enhanced Water Condensation Rate by the Mirco/nano Textured Surface

Wan-Doo Kim, Duck-Gyu Lee, Sunjong Oh, Hyuneui Lim
Korea Institute of Machinery & Materials, Departmenet of Nature-Inspired Nanoconvergence Systems
156 Gajeongbuk-Ro, Yuseong-Gu, Daejeon 34103, Republic of Korea
wdkim@kimm.re.kr; educk9@kimm.re.kr; ssun@kimm.re.kr; helim@kimm.re.kr

Extended Abstract

Morphological studies on the surfaces of insects and plant leaves in arid and humid environments have led to the understanding of the role played by those surfaces for living in the harsh environments. Especially, the functional surface for the water condensation has been growing interest due to its relevance to the global issue of a water shortage.

Motivated by the water harvest behaviour of beetles [1], we developed a high efficient surface for the water condensation. The functional surface was mimicked by the insect of which cuticles harvest water even in the water shortage region like a desert. It is well known that the surface of the insect is superhydrophilic so that the surface easily enables the humid air to be nucleated there.

To make such a high energy surface, we treated a substrate using a metallizing method. The metallizing is a process for the metal coating onto the surface of objects. We used aluminium wire with 390 μm in diameter and fed into a hot nozzle at a rate of 110 mm/s to melt it. The air was blown into the nozzle and then the melted aluminium metal spreads to the substrate in the form of mico/nano powders. To deposit the metal uniformly onto the surface, we varied the angle of blowing and the number of coating. We experimentally found the optimized conditions for the uniform coating.

During the water condensation, the surface wettability plays an important role as aforementioned. However, the persisting wettability is another critical parameter that affects the performance of water condensation. To sustain the wettable surface, we chemically oxidized the substrate with a surfactant. We first mixed the surfactant powder with distilled water in the ratio of 1 to 20 by weight. Then the aluminium metallized substrate was immersed into the surfactant liquid and sonicated for 15 min. The substrate was finally rinsed with distilled water for 15 min and dried by blowing nitrogen gas. To quantify the maintenance duration of the wettability, we measured the contact angle of the substrate with water every day. We observed that the surfactant treatment allows the wettability to last over 140 days.

To verify the enhanced water condensation rate by the surface, the metallized substrate after the treatment of oxidation was exposed to the humid air. We performed the experiment in the constant temperature and humidity chamber with T=27 ℃ and RH=60 %. Since the water condensation occurs on the cooled surface, the substrate was equipped to the cooled substrate operated by a Peltier element. The cooled substrate was set to maintain the temperature of T=11 ℃, which corresponds to the dewing temperature under the condition of the chamber environment. We observed that the surface enhanced the water condensation rate by 130 % compared to the non-treated substrate. Our functional surface for the water condensation would be expected to use as a cooling fin of a dehumidifier for a commercial use.

References

[1] T. Nørgaard and M. Dacke, "Fog-basking behavior and water collection efficiency in Namib desert darkling beetles," *Front. Zool.*, vol 7, pp. 23-30, 2010.