Enhanced heat transfer in air-conditioner heat exchanger using superhydrophobic foils

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Abstract Air-conditioners have the highest energy consumption among the household appliances because of the improved thermal resistance by the filmwise condensation in summer and frosting in winter on the surface of hydrophilic foils of heat exchanger. The wet foils are also easy to adsorb dirts and reproduce bacteria, further affecting people health in the room. Here, through chemical oxidation and subsequent chemical modification, we fabricated superhydrophobic nano-arrays on the packed aluminum-foils and then assembled a novel air-conditioner heat exchanger using the foils. The foils showed high performance in self-cleaning, anti-condensation, anti-frosting, anti-corrosion and environment stability, promising a good candidate for improving energy efficiency of air-conditioners in future. The results of testing revealed that the cooling capacity and heat transfer coefficient from superhydrophobic heat exchanger increasing over 8 and 2 percent than conventional hydrophilic one under rated output working conditions. Moreover, the superhydrophobic exchanger under the condition of frosting has higher energy conversion (over 85%) than the conventional hydrophilic one after 60 min.

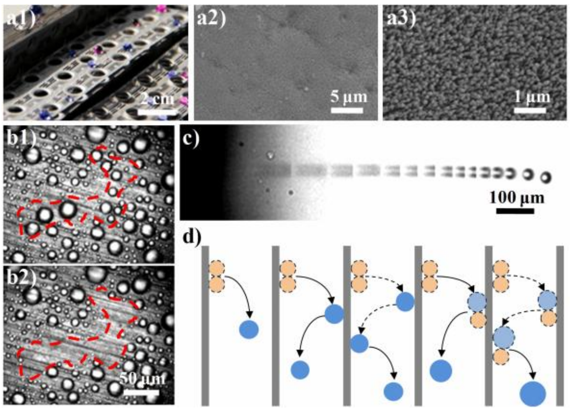

Fig.1 Superhydrophobicity and condensation behavior of the superhydrophobic aluminum foils. ***a)*** *Superhydrophobicity and FESEM image of the superhydrophobic nano-arrays on the foil surface.* ***b)*** *Time lapse images of condensation captured via a high speed camera, showing a self-jumping behavior of sveral drops on a horizontally placed foil from the side- and top-view (Δt < 0.1 s).* ***c)*** *The self-jumping movement track of a dewdrop with a diameter of ~30 μm demonstrated by an overlapped optical image on a vertically placed foil from the side-view.* ***d)*** *Schematic illustration of five possible modes of the jumping drops keeping the fins always dry.*

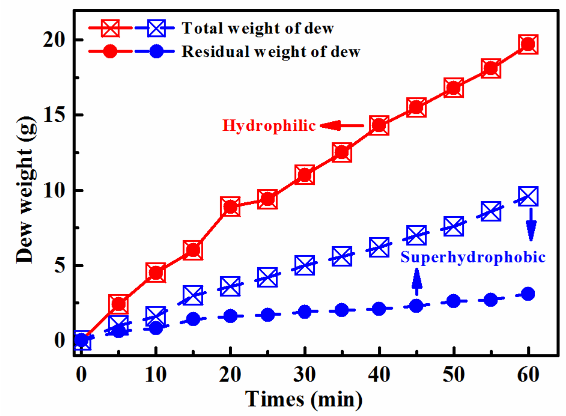

Fig. 2 Condensation characteristics of the superhydrophobic and hydrophilic heat exchanger. The change of the dew weight recorded per 5 minutes.

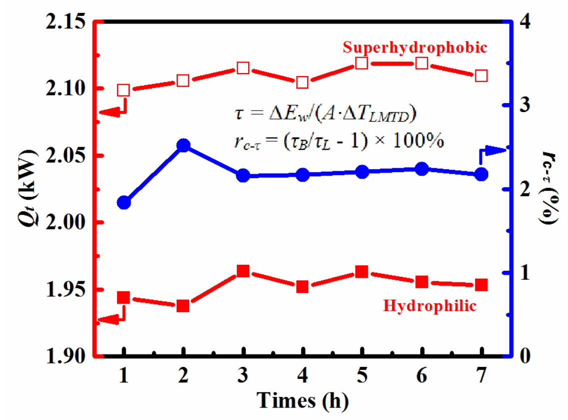

Fig. 3 The total cooling capacity Qt (square) and the growth index of rc-τ (circle) were calculated. All of the values were fluctuated in a tiny scope, and the HT performance of the superhydrophobic exchanger is apparently higher than the conventional hydrophilic one.

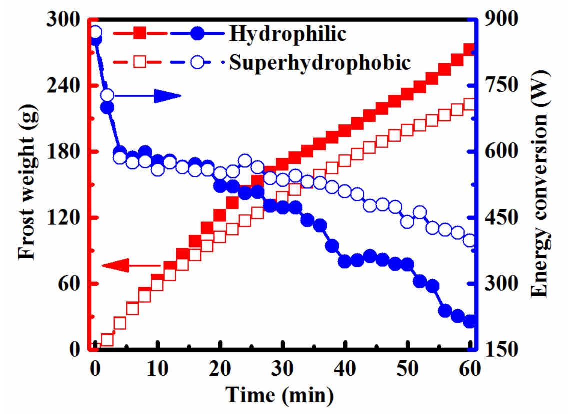

Fig. 4 The change of frost weight and energy conversion of the hydrophilic and superhydrophobic exchanger with time.

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