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Investigation of dropwise condensation on PTFE-based coated surfaces

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Enhancing heat transfer rates during condensation has been at the core of numerous researches as it will lead to increased efficiencies and productivities for various fields especially for power generation(1). Since the major limitation to heat transfers comes from the poor thermal conductivity of the liquid condensate film, the idea is to prevent the condensate layer from forming by promoting prompt removal of the droplets. The main solution consists in tuning the topography or chemical nature of the condensing tubes' surfaces to increase the hydrophobicity, through the use of coatings or surface treatments, in order to promote dropwise condensation, in opposition with filmwise condensation usually observed in actual industrial condensers (Fig 1.). Indeed, considering the weak affinity between water and an hydrophobic surface, as a droplet gets to a certain size it will, under the effect of gravity, depart from the surface sweeping others on its path allowing for new droplets to emerge.

To achieve dropwise condensation, highly fluorinated monomer/polymers are generally used in order to increase the hydrophobicity of the surface. This study focus on the interest of Poly Tetra Fluoro Ethylene (PTFE) based coatings as a mean to enable dropwise condensation. PTFE was chosen due to its properties such as chemical resistance, thermal stability and low surface energy.

For the first set of tests, the template method was used to alter the topography of the surface using different meshes (Fig. 2.a and 2.b). The pressed surfaces were then annealed either to 250°C or 370°C. Contact angles were then measured between 137°±3° and 153°±3° depending on the annealing temperature. The difference in contact angles comes from the fact that the annealing temperature 370°C is superior to the melting temperature of PTFE (327°C) leading to a change of morphology of the PTFE-nanoparticles who melts and merge to form filaments (Fig. 2.c and 2.d).

Condensation was then first investigated using VHX microscope and a vaporizer (Fig. 3). The control over ambient pressure and vapor temperature being too limited and the results being inconclusive concerning the possibility of continuous dropwise condensation, tests are soon to be made in a vapor chamber. However, the experiment showed great promises especially through high nucleation density (Fig 3).

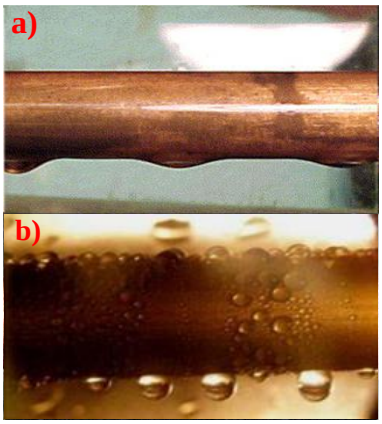

Fig.1. a) Filmwise condensation vs b) Dropwise condensation
(2)

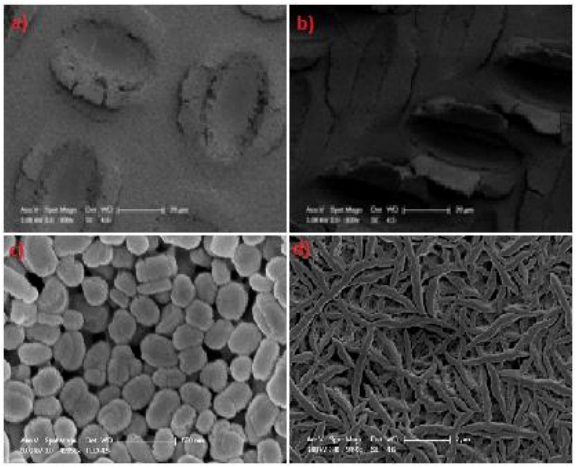

Fig.2. SEM images of the pressed surfaces and nanoscale-structure
a) b) meshes imprints,　c) 250°C and (d)370°C annealing

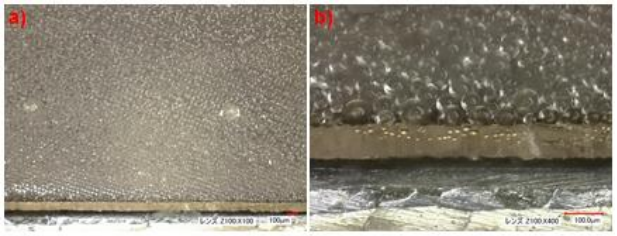

Fig.3. VHX microscope images

<References>

(1) Kim, S., & Kim, K. J. (2011). Dropwise condensation modeling suitable for superhydrophobic surfaces. *Journal of heat transfer*, *133*(8).
(2) http://science.energy.gov/sbir/highlights/2013/sbir-2013-01-d/