4) Nature-inspired water and ice-repelling nanostructured surfaces

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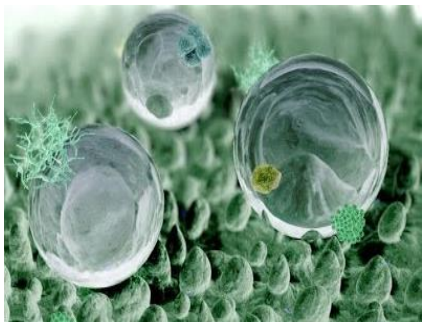
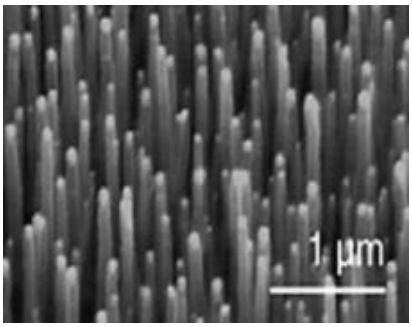
Recently, many nanofabricated surfaces with unique physical and chemical properties like super sticky, self-cleaning, hydrophilic, hydrophobic, ice-phobic, anti-fouling properties and with their combinations (multi-purpose smart surfaces) have been elaborated. Many important physical and geometric principles of their structure and function can be taken from nature, for instance self-cleaning lotus leaf, super sticky glue from mussels, super-hydrophobic surfaces of insects, air-accumulating surfaces of some leaves and water insects, ice-phobic insect eyes and many others. Modern water and ice-repelling surfaces must sustain different ambient conditions (temperature, pressure, humidity, wind), that needs elaboration of smart nanostructures of different materials.

In this project, the student will familiarize with irreversible thermodynamics at the microscale and learn how the surface geometry and physical parameters influence its water- and ice-repelling abilities. The project will be carried out according to the following steps:

1. Classification of the nanostructured natural surfaces discovered in plants and animals and studied in literature.
2. Discussion of the physical and chemical mechanisms of the “smartness”.
3. Elaboration of simplifies models of the nanostructured natural surfaces and computations of their surface energy.
4. Comparative analysis of their smart properties and propositions for experimental verification of theoretical results and discussion of possible application.

Literature

1. Jeevahan J., M. Chandrasekaran, G. Britto Joseph, R.B. Durairaj,G. Mageshwaran, Superhydrophobic surfaces: a review on fundamentals,applications, and challenges, J. Coat. Technol. Res. 15 (2018) 231–250.
2. Nguyen-Tri P., H.N. Tran, C.O. Plamondon, L. Tuduri, D.-V.N. Vo, S. Nanda,A. Mishra, H.-P. Chao, A.K. Bajpai, Recent progress in the preparation, propertiesand applications of superhydrophobic nano-based coatings and surfaces: areview, Prog. Org. Coat. 132 (2019) 235–256.
3. Yancheshme A.A., G. Momen, R. Jafari Aminabadi, Mechanisms of ice formation and propagation on superhydrophobic surfaces: a review, Adv. Colloid Interface Sci. 279 (2020) 102155.