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The Self-Cleaning Mechanism: Why Nanotexture and Hydrophobicity Matters

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Abstract:

Dust particles can adhere to surfaces, and thereby, they can decrease the efficiency of diverse processes, such as light absorption by solar panels. It is well known that superhydrophobicity reduces the friction between water droplets and the surfaces, thus, allowing water drops to slide/roll and detach (clean) particles from the surfaces – this is the so called "self-cleaning" mechanism. However, the forces that attach and detach particles from surfaces during the self-cleaning mechanism, and the effect of nanotextures on these forces, are not fully understood. To shed light on these forces, and the effect of nanotexture on them, we prepared four Si-based samples (relevant to solar panels): (1) Smooth or (2) nanotextured hydrophilic surfaces, and (3) smooth or (4) nanotextured hydrophobic surfaces. In agreement with previous publications, it is shown that the efficiency of particle removal increases with hydrophobicity.

Furthermore, nanotexture enhances the hydrophobicity, whereby particle removal is further increased. Specifically, hydrophilic particle removal increased from ~41%, from hydrophilic smooth Si wafer, to 98% from superhydrophobic Si-based nanotextured surfaces. However, the reason for the increased particle removal is not low friction between the droplets and the superhydrophobic surfaces; it is the reduction of adhesion force between the particle and the surface, and the altered geometry of the water-particle-air line tension acting on the particles on superhydrophobic surfaces, which increases the force that can detach particles from the surfaces. The experimental methods we used, and the criterion for particle removal we derived, can be implemented to engineer self-cleaning surfaces using other surfaces and dust particles, exhibiting different chemistries and/or textures.

Date & Location:

Tuesday, October 29, 2019, 11:00
Lecture room, Physics Building (ground floor)