Teaching Activities for the Introduction of Superhydrophobicity in Secondary Education

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What is Superhydrophobicity?

Superhydrophobicity refers to the water repellent property of some leaves, due to the architecture of their surface at micro- and nano-scale, which minimizes the adhesion of droplets (Fig. 1).

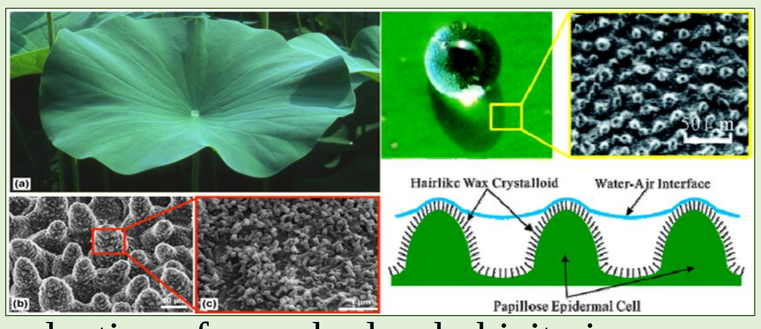

Figure 1: The surface roughness of the lotus leaf at micro- and nanoscale.

This work suggests a proposal for the introduction of superhydrophobicity in secondary education for senior high school students, through the development of appropriate instructional materials and collaborative hands-on activities.

Materials & Methods

The scientific content for leaf surface characterization was identified through the corresponding section from Bhushan's (2012) book.

The educational reconstruction was based on the MER model (Duit et al., 2012).

It was also taken into account the Big Idea "Size-Dependent Properties" of NSE from the book of Stevens et al. (2009).

Scientific Content

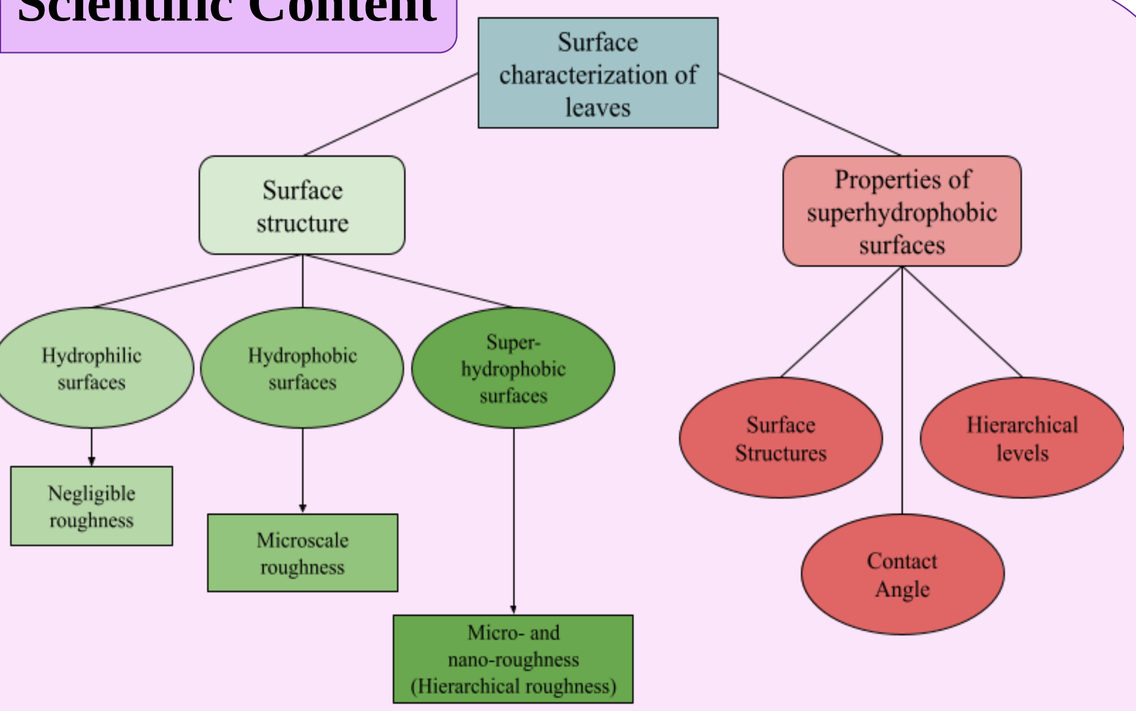

Figure 2: Scientific content of the surface characterization of leaves.

Instructional Goals

- Explain that natural water-repellent surfaces have hierarchical structure, which combined with the nanoscale roughness of the wax prevents the gaps between the bumps from filling with liquid.
- Describe the wetting behavior of various plant leaves according to the shape of the water droplet.
- Correlate the water repellent properties with the surface structure of the leaves.
- Use models of the lotus leaf micro- and nano-structure to predict its water-repellent properties.
- Describe situations in which a superhydrophobic surface would be useful in everyday applications.

Conclusions

Through this work, students will be able to recognize the surface characteristics of a leaf, to describe its properties, to justify the shape of the droplet based on the comparison of the sizes of the micro- and nano-structures that form on its surface, but also to give examples of technological applications in everyday life.

RESEARCH COMMITTEE
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Teaching Activities

Basic concepts: hydrophilic-hydrophobic surfaces. Students split into small groups (3-4 persons). The teacher gives a short introduction to the basic concepts of the course (Fig. 2).

Surface characterization of leaves – contact angle. Each group tests using optical microscope the shape of a water droplet on leaves of different plants and classifies the wetting behavior according to their contact angle (Fig. 3).

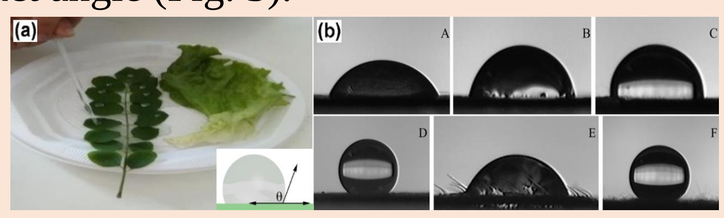

Figure 3: (a) Acacia and lettuce leaves, (b) Contact angles of droplets on different leaf surfaces.

Superhydrophobic surfaces – Lotus effect. Students watch a video about the lotus effect (Fig. 4).

Figure 4: Digital camera lotus leaf surface images.

Roughness & Hierarchical Structure of the Lotus Leaf. Each group discuss the structure of lotus leaves and their superhydrophobic properties (Fig. 5).

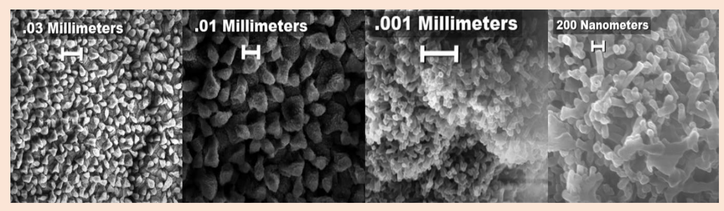

Figure 5: SEM images of the surface structure of the lotus leaf.

Recreation of superhydrophobic surfaces. Each group recreates the leaf surface to explain the effect through micro- and nano-structure on the water droplet shape (Fig. 6).

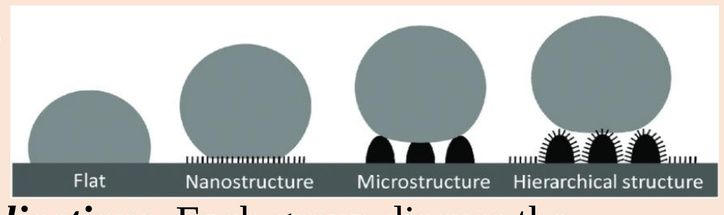

Figure 6: Wetting types of leaves according to their surface roughness.

Superhydrophobic applications. Each group discuss the contribution of superhydrophobicity in relation to everyday technological applications and they present their findings (Fig. 7).

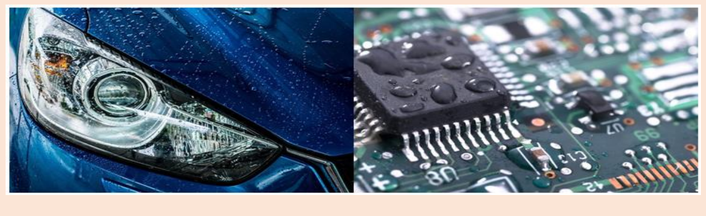

Figure 7: Nano-coatings have a wide range of applications.