Abstract

Humans have always looked to nature for inspiration to solve problems. Learning from Nature in materals science means taking ideas and developing novel functional materials based on these concepts. Recently some less complex, but nonetheless, special features in biology received intense attention, such as the selfcleaning effect of lotus leaves and duck feathers, the non-fogging, superhydrophobic compound eyes of mosquitoes, the locomotion of geckos and octopuses via highly adhesive feet and suckers and, lastly, the movement of some insects on liquid surgaces. All these features are suitable for bio-inspiration and, by studying them, humans can be taught a lot about the way nanostructures affect some properties such as the wetting mechanisms and adhesive forces.

For example, some unwanted plants or weeds, like the gorse (Ulex europeaus) that was reported in New Zealand, have waxy surfaces on their leaves that makes particularly difficult their wetting with water-based herbicides. However, the super-wetting material trisiloxane was developed because of its unique ability to wet such difficult surfaces and improve the performance of the herbicides.

The most common example of a superhydrophobic surface is the lotus leaf (Nelumbo Nucifera). Electrons Microscopy on its leaves has showed that this plant has a unique structure. They possess a dual-scale roughness one on the magnitude of 10μm and another of 100nm. Many studies in this field have shown that the combination of micro- and nano- roughness and the low surface energy of the waxed surface of this plant are responsible for the self-cleaning effect. First Kao et al. presented artificial superhydrophobic surfaces based on this effect in the mid 1990s.

This dissertation aims to present how smart surfaces based on these phenomena can switch from the superhydrophobic to superhydrophilic state. The ability to control the wetting properties of a surface offers plenty of opportunities for practical applications that include drug delivery, self-cleaning, microelectronics and microfluidic devices to name a few. This dissertation focused mostly on the photoswitchable surfaces based on the photoresponsive properties of spiropyran-based molecules that, upon UV light exposure, undergo an isomerization process through a heterocyclic ring cleavage to the polar merocyanine (MC) form which is purple. Irradiation with visible light converts the MC open form into the colorless, nonpolar closed spiropyran (SP) isomer.

Through the experimental study of these surfaces, one is able not only to demonstrate the ability of these surfaces to change their contact angle but also to study which factors affect this mechanism and how their performance can be improved.