Biomimetic Research Inspired from Nature

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Abstract

Is this workshop we present the progresses of two research programs inspired from nature. The research idea of the first part originated from the so-called “lotus effect” and the target is combine the droplet dynamics and the surface science on the hybrid ultra-hydrophobic surfaces to develop novel biochips. The concepts of the second part of the presentation come from flying creatures and the mid-term goal is to develop the unmanned flight vehicles.

In nature, the surface of a lotus leaf is well known to possess two outstanding properties – superhydrophobic and self-cleaning. According to the surface morphology observed with a scanning electron microscope, these two advantages are attributed to a doubly structured rough surface on the lotus leaf: fine-scale structures, made of epicuticular wax crystals, have sizes in a range 1 – 200 nm, whereas coarse-scale structures, made of protrusions of cuticle, have sizes in a range about 20 m. Such hybrid structures on a lotus leaf are effective to prevent dust and contaminants from adhering to its surface. Besides waterproof plants such as the lotus leaf, hybrid-structured surfaces exist elsewhere in nature, such as on the wings of butterflies. Many scientists have been interested in such wondrous interfacial behavior that inspires chemical and physical research on the composite organization and superhydrophobicity of hybrid-structured surfaces.

The concept of a lotus leaf with hybrid-structured surfaces has been mimicked and integrated into artificial superhydrophobic surfaces; varied materials and novel approaches have been investigated and developed in the related literature. Different from the above approaches, we investigated another hybrid-structured surface with water-repellence and anti-sticking character, appropriate for a silicon substrate. The behavior and characteristics of static and dynamic interface contacts between microdroplets and those hybrid-structured surfaces are to be presented and discussed in the workshop.

In the second part, the experimental analysis of biomechanics on fish, butterfly, and birds are to be reported. The biophysics and biomechanics

involved in the locomotion of a swimming fish, the free-flight insects, and the flying birds have attracted the attention of engineers and scientists. Understanding the dynamic characteristics and propulsion principles exploited by a those creatures is significantly helpful in the design of a biomimetic vehicles that is highly efficient and highly maneuverable.

Bibliography

Professor Yang received his Ph.D. from the Energy Division in the Mechanical Engineering Department at the University of Wisconsin at Madison in 1983. He had worked on the faculty at National Tsing Hua University during 1983-2008. His current research topics contain energy and environmental engineering, microfluidics and biofluidics, biomimetic engineering and biomechanics, jet propulsion, and laser diagnostics. He has received the 2008 National Award of Invention and Creation, the 2007 National Innovation Award (on biotechnology), the awards of the outstanding engineering professor of the Society of Chinese Engineers, the outstanding engineering professor of the Chinese Society of Mechanical Engineers, the outstanding research award of the National Science Council.

Dr. Yang has been the chairman of PME department (1997-2000) at NTHU, the director of Tzi-Chiang Science Research Center at NTHU, the member in the board of directors of Automobile Research and Testing Center (2000-2006), the general director of nanotechnology human resource development program office, the general coordinator of the reviewing committee of annual energy projects of the Energy Bureau of the Economy Ministry, the consultant in the Steering Committee for Energy Policy and Technological Development of Executive Yuan, the director of the Office for Energy Strategy Development of the Steering Committee for Energy Policy and Technological Development of Executive Yuan. Currently, he serves as the director of the Office for Energy Strategy Development of the National Science Council, the principal commissioner of the energy planning and management program of National Science Council, and the consultants of the National Project on Nanotechnology, Chung-Hua Institution for Economic Research, and Science and Technology Advisory Group of Executive Yuan, respectively.