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Young Researchers in Mechanical Engineering

Mechanics of bioinspired nanostructures: Toward mechanically robust antireflective surface

SPEAKER

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ABSTRACT

Biological nanostructures found in nature, such as moth eyes and lotus leaves, achieve remarkable antireflection and self-cleaning properties through their nanostructured surfaces. Translating these concepts into engineered materials offers opportunities to create surfaces that are simultaneously antireflective, self-cleaning, and mechanically durable. In this talk, I will present our recent progress in the design and characterization of sub-wavelength nanopillar arrays, inspired by the moth eye, on sapphire and silicon substrates. I will discuss how nanopillar geometry governs mechanical properties, optical transmission, wetting behavior, and dust-mitigation performance. The main focus of the presentation will be the mechanical characterization of these nanostructured surfaces. Using interference lithography and inductively coupled plasma reactive ion etching (ICP-RIE), we fabricate nanopillar arrays with varying aspect ratios. Mechanical modeling of the pillars together with nanoindentation measurements reveal how aspect ratio influences deformation mechanisms, stiffness, and hardness. Mechanical and optical tests show that sapphire nanostructures exhibit hardness and indentation modulus comparable to those of bulk glass and scratch-resistant metals, while simultaneously enhancing optical transmission. These findings provide new insights into the deformation behavior of nanopillar arrays and reveal design principles for mechanically durable, multifunctional surfaces. The results highlight the potential of nanostructured materials for mechanically robust antireflection surfaces and for applications in photonics, sensing, and display technologies.

ABOUT THE SPEAKER

Mehmet Kepenekci is a Ph.D. candidate in Mechanical Engineering at The University of Texas at Austin, working in the Nanostructures & Nanomanufacturing Laboratory under the supervision of Prof. Chih-Hao Chang. He received his B.S. (2018) and M.S. (2021) degrees in Mechanical Engineering from Middle East Technical University in Ankara, Turkey. His research focuses on the fabrication and characterization of bioinspired nanostructures for fabricating mechanically robust multifunctional nanostructured surfaces. His current work examines how nanopillar geometry influences the deformation, hardness, and scratch resistance of subwavelength nanopillar arrays on sapphire and silicon substrates.

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