Sapphire Nanostructures That Repel Glare, Dust, and Fog

Posted by Okachinepa 03/25/2025

Courtesy of SynEvol
Credit: University of Texas at Austin

Envision a phone display that remains perfect regardless of how often you drop it, eyewear that removes glare, or a windshield that stays dust-free. These may soon become a reality due to a novel technique for creating sapphire.

Scientists at The University of Texas at Austin have created unique methods to grant superpowers to sapphire, a substance typically regarded merely as a gemstone but prized in sectors from defense to consumer electronics. Its remarkable hardness renders it almost unscatchable, making it perfect for high-performance uses.

“Sapphire is a valuable material due to its toughness and various other advantageous characteristics,” stated Chih-Hao Chang, associate professor in the Walker Department of Mechanical Engineering and principal investigator on the study. "However, those identical characteristics also render it quite challenging to produce on a small scale."

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Chang and his team aim to alleviate this issue with innovative sapphire-based nanostructures as reported in Materials Horizons. The nanostructures exhibit the highest aspect ratio observed so far for this material, allowing its enhanced capabilities while maintaining its stiffness and hardness.

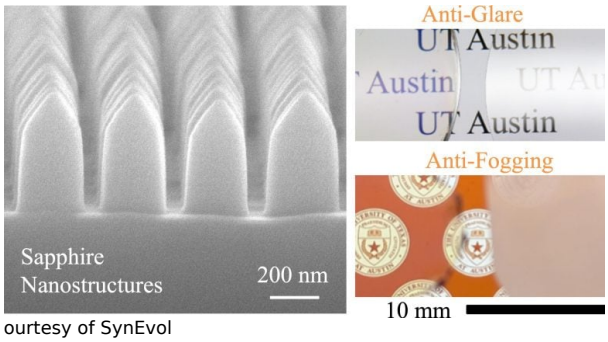
The study: Although these new sapphire nanostructures aren't as scratch-resistant as conventional bulk sapphire – they are similar to tungsten or standard glass in this regard – they effectively repel fog, dust, and glare while possessing self-cleaning properties.

"This is quite thrilling as nanostructures are usually considered delicate, but fabricating them in sapphire can address this issue," noted Kun-Chieh Chien, a fresh Ph.D. graduate from Chang's lab and one of the primary authors.

Drawn from the moth eye, the tapered design of the sapphire nanostructures improves light transmission and minimizes glare. The elevated surface energy and aspect ratio of the nanostructures result in a superhydrophilic surface that inhibits fog formation. The structures can likewise be designed to function as a superhydrophobic surface, enabling water droplets to glide off, similar to the effect seen in lotus leaves.

“Our sapphire nanostructures are both multifunctional and mechanically strong, which makes them perfect for applications that require durability and performance,” stated Mehmet Kepenekci, a graduate student in Chang’s lab and a lead author.

Why it's important: This technology offers numerous advantages. For consumers, this might result in smartphones that are simpler to view in difficult lighting situations, lenses and windows that remain clear, cameras that resist glare, and durable windshields that avoid dust accumulation.



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As we begin the next era of space exploration, the anti-dust features may guarantee that essential equipment remains free of dust buildup during landing missions on other planets, for instance. It may result in the development of more robust infrared sensors and protective windows for defense uses.

“Our self-cleaning sapphire surfaces can achieve 98.7% dust-free areas through gravity alone,” stated Andrew Tunell, the student who performed the dust adhesion tests. “This marks a notable advancement compared to current dust-mitigation technologies and is especially advantageous for use in space, where water is not easily accessible for cleaning.”

What’s next: The researchers plan to make this technology a reality and seek to enhance it in various ways. They are increasing production to apply these nanostructures on larger samples, enhancing mechanical and chemical properties to boost their capabilities and investigating additional practical applications.
