

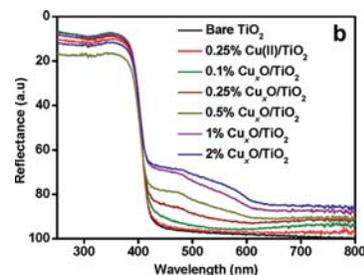
Shining a New Light on Indoor Risk Reduction

■ Volatile organic compounds (VOCs) and pathogens, including infectious bacteria and viruses, can both create poor indoor air quality, harming human health. For environmental remediation of these components outdoors, previous research has shown that the photocatalyst TiO₂ can be effective when used as a coating. However, this molecule is only activated by intense ultraviolet light, disqualifying it for indoor use. To sensitize TiO₂ for indoor light, some researchers have tried doping this photocatalyst with transition metal ions or with anions. However, the resulting materials have shown low light-harvesting efficiency and poor performance.

Seeking a novel material that both neutralizes VOCs and provides antipathogenic activity, Qiu *et al.* (DOI: 10.1021/nn2045888)

combined TiO₂ with Cu^I and Cu^{II} species because previous work has indicated that Cu^{II} can oxidize VOCs and Cu^I has antibacterial and antiviral properties. The researchers grafted nanoclusters containing Cu^I and Cu^{II} onto TiO₂ particles in powders, confirming their presence with spectroscopic, microscopic, and other techniques. They then evaluated the effectiveness of their samples in eliminating VOCs and pathogens under visible light illumination characteristic of indoor environments. Their findings show that after exposure times of 96 h, the combined material eliminated a model VOC completely, unlike bare TiO₂ or TiO₂ doped with nitrogen. Similarly, the TiO₂/Cu nanocluster combination, coated onto glass substrates, was highly effective at killing bacteria and viruses. This last ability was present not only

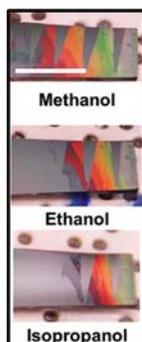
under visible light but also under dark conditions. The researchers suggest that these hybrid nanocomposites could be useful for a wide range of air purification applications.



Color Me Novel

■ Structural color relies on the physical properties of a material, such as its shape and density, rather than the chemical properties of pigments. This quality has attracted increasing attention from the research world since by these means materials are highly tunable, opening the possibility for easy-to-read, self-reporting sensors that go beyond the current array of commercially available colorimetric diagnostic tests. Because structural color does not rely on chemical state, sensors based on this factor would not need to rely on the chemical properties of a given system. Any new diagnostic based on structural color would need to be able to encode multiple responses from a single material, be highly sensitive to some general property for a class of materials, and produce a colorimetric response that is easy to read.

In a proof-of-principle study, Burgess *et al.* (DOI: 10.1021/nn204220c) produced a novel colorimetric sensor that meets



each of these requirements. They base their novel wetting-in-color-kit (WICK) on defect-free silica inverse opal films (IOFs), a material that is well recognized to produce

iridescent structural color. Relying on the minute differences in wetting between different liquids, the researchers developed IOFs that were chemically modified using a combination of two different alkylchlorosilanes to allow different amounts of liquid into pores. This technique provided colorimetric discrimination between various concentrations of ethanol, ranging from 85 to 100%. Taking this technique a step further, they exposed the modified IOFs to short bursts of oxygen plasma, affecting how pores filled. This allowed further discrimination of various other alcohols and alkanes. The authors suggest that WICK could have applications ranging from detection of forgeries to in-field identification of liquids.

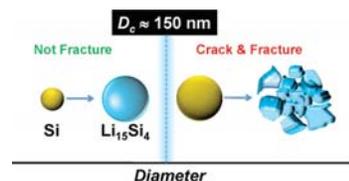
What Makes Lithiated Silicon Nanoparticles Crack

■ Lithium batteries are already being used in a variety of small consumer electronics. To move these batteries into more demanding applications, such as electric cars, researchers will need to improve energy density and power capability radically. One material considered to be a promising anode candidate is silicon, which has a Li storage capacity about 10 times higher than that of carbonaceous anodes. However, Si expands to nearly three times its volume when alloying with Li, resulting in pulverization and loss of electrical contact, which leads to fading capacity with Si-based electrodes. Nanostructured Si-based electrodes somewhat mitigate these effects. However, thus far, researchers have not known the critical size above which lithiated Si nanoparticles break apart.

To answer this question, Liu *et al.* (DOI: 10.1021/nn204476h) lithiated individual

spherical Si nanoparticles inside a transmission electron microscope to examine their behavior closely. Findings showed that during electrochemical or constraint-free chemical lithiation, nanoparticles above about 150 nm in diameter developed cracks and eventually fractured into multiple pieces when their Li_xSi shell reached the same thickness. Si nanoparticles smaller than this diameter did not crack or fracture, even though they underwent a nearly 300% volume expansion. The researchers suggest a mechanism in which a large buildup of tensile hoop stress reversed initial compression of the surface layer, resulting from movement of a two-phase boundary between the inner Si core and the outer Li-Si coating. Stored strain energy between the core and shell were not enough to drive fracturing in the smaller nanoparticles. The authors suggest these findings could

help build more reliable and more stable Li batteries with Si anodes.



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