Longhorn beetle inspires ink to fight counterfeiting

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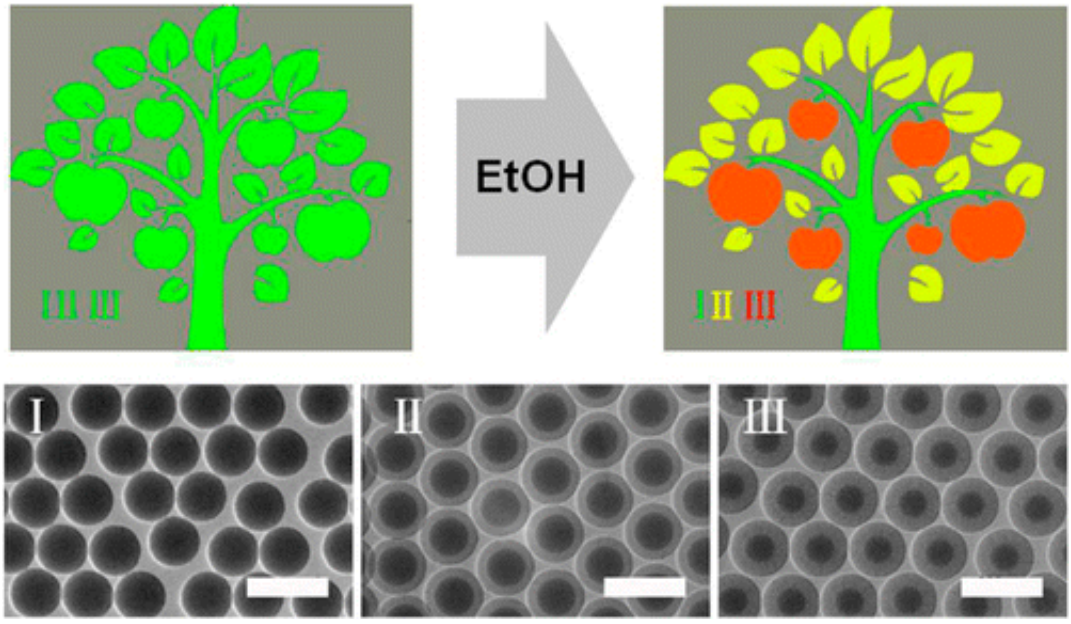

From water marks to colored threads, governments are constantly adding new features to paper money to stay one step ahead of counterfeiters. Now a longhorn beetle has inspired yet another way to foil cash fraud, as well as to produce colorful, changing billboards and art displays. In the journal *ACS Nano*, researchers report a new kind of ink that mimics the beetle's color-shifting ability in a way that would be long-lasting and difficult to copy.

Zhongze Gu, Zhuoying Xie, Chunwei Yuan and colleagues explain that some U.S. bills have color-changing features to help thwart attempts by counterfeiters to make fake money. But these features based on the chemical structural changes of dyes, pigments or polymers tend to fade when exposed to light and air. Researchers have been developing a new set of color-changing materials known as colloidal photonic crystals that are bleach resistant.

The methods that use these crystals remain expensive, however. Inkjet printing is a fast, precise and low-cost alternative, but until now, researchers had not developed the right inks for making such color-changing and complex patterns. For inspiration, Gu's team turned to *Tmesisternus isabellae*, a longhorn beetle that can shift from gold to red and back again, depending on the humidity.

The researchers designed an ink that they can finely tune to change color, for example, from bright green to yellow or red when exposed to ethanol vapors. It can also return to its original color. The ink is also durable, resistant to bleaching when exposed to light and can be applied to hard or flexible surfaces.

More information: "Bio-Inspired Vapor-Responsive Colloidal Photonic Crystal Patterns by Inkjet Printing" *ACS Nano*, Article ASAP. DOI: 10.1021/nn504659p

Abstract
Facile, fast, and cost-effective technology for patterning of responsive colloidal photonic crystals (CPCs) is of great importance for their practical applications. In this report, we develop a kind of responsive CPC patterns with multicolor shifting properties by inkjet printing mesoporous colloidal nanoparticle ink on both rigid and soft substrates. By adjusting the size and mesopores' proportion of nanoparticles, we can precisely control the original color and vapor-responsive color shift

extent of mesoporous CPC. As a consequence, multicolor mesoporous CPCs patterns with complex vapor responsive color shifts or vapor-revealed implicit images are subsequently achieved. The complicated and reversible multicolor shifts of mesoporous CPC patterns are favorable for immediate recognition by naked eyes but hard to copy. This approach is favorable for integration of responsive CPCs with controllable responsive optical properties. Therefore, it is of great promise for developing advanced responsive CPC devices such as anticounterfeiting devices, multifunctional microchips, sensor arrays, or dynamic displays.

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