Self-destructing messages: Light-reactive coatings make metal nanoparticles into inks for self-erasing paper

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(PhysOrg.com) -- Those who like to watch spy movies like “Mission Impossible” are familiar with the self-destructing messages that inform the secret agents of the details of their mission and then dissolve in a puff of smoke. In the real world, there is serious interest in materials that don't exactly destroy themselves, but that store texts or images for a predetermined amount of time.

“Such re-writable ‘paper’ would protect sensitive information,” Bartosz A. Grzybowski of Northwestern University in Evanston (IL, USA) explains. “Imagine a meeting in the Pentagon where the classified materials self-erase when the meeting is over. No way to take them away and sell to terrorists.“ He and his team have developed a new concept that can be used to produce self-erasing pictures. In contrast to previous techniques, their method allows for multicolored pictures. As the researchers report in the journal Angewandte Chemie, their concept is based on an ‘ink’ made of nanoscopic metal particles that clump together—in a reversible process—under the influence of light.

To make this new re-writable material, the researchers embed silver and/or gold nanoparticles in a thin film of an organic gel, which they then laminate. The films are bright red if they contain gold particles, and yellow if they contain silver. When these films are irradiated with UV light, the color of the film changes in the irradiated regions. The degree of difference depends on the duration of the irradiation. Gold-containing

films change stepwise from red to pale blue; those containing sliver change from yellow to violet. Multicolored pictures can be produced if different areas are irradiated for different amounts of time. The resulting pictures are not permanent; they fade until they are completely erased.

How does it work? The trick lies in a special organic coating on the metal nanoparticles. Under UV light, certain groups of atoms in these molecules rearrange. This makes them more polar, which causes them to attract each other more strongly. The nanoparticles then prefer to clump together in large spherical aggregates. The color changes because the color of nanoscopic particles is dependent on the size of the aggregates they form. The size of the aggregates, in turn, depends on the duration of the UV irradiation. In this way, the color of the ink can be controlled.

The particle aggregates eventually break up into individual metal nanoparticles because the groups of atoms return to their original arrangements, and the color fades. The time it takes for the picture to be erased can be controlled by means of the exact composition of the coating. The erasure can be accelerated by irradiation with visible light or by heating.

More information: Bartosz A. Grzybowski, Writing Self-Erasing Images using Metastable Nanoparticle "Inks"; *Angewandte Chemie International Edition* 2009, 48, No. 38, 7035-7039, doi: 10.1002/anie.200901119

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