

Combining cheap and safe black and white materials creates colorful pigments

September 23 2019, by Yukikazu Takeoka

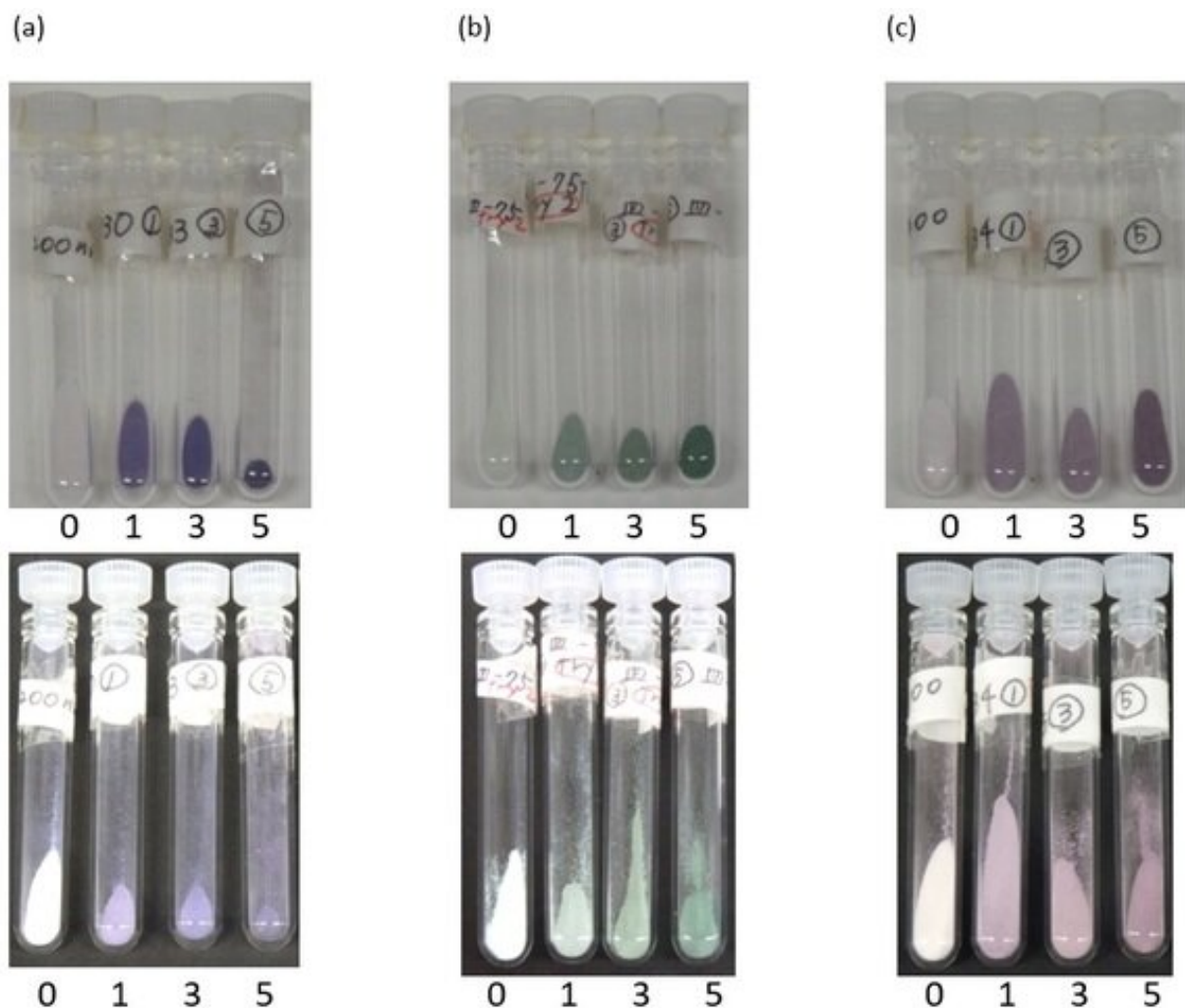


Figure 1: Photographs of spherical colloidal crystals composed of silica fine particles or silica fine particles coated with Fe - TA film with black and white backgrounds: (a) A system using silica fine particles with a particle size of 200 nm. (b) A system using silica fine particles with a particle diameter of 250 nm.

(c) A system using silica fine particles with a particle diameter of 300 nm.
Credit: Nagoya University

In response to worldwide concern over the adverse effects of chemical substances on human health and the environment, most developed countries have legally restricted the use of dyes containing heavy metals or carcinogenic organic compounds; thus, replacing such color materials with safer substances is an urgent issue. Motivated by this, a Nagoya University research group has found that pigments of various colors can be obtained by combining fine silica particles (white powder) and a complex of iron and tannic acid (black compound), both of which are inexpensive and harmless substances used for foods and cosmetics. The pigments are expected to be an alternative to conventional harmful color materials. This study was reported in *ACS Sustainable Chemistry & Engineering* on August 8, 2019.

Some conventionally used pigments and dyes contain [heavy metals](#) and are carcinogenic, bringing about the need to replace them with cheaper and safer colorants. In this research, the group prepared safe and inexpensive pigments using fine particles based on silica, which is abundant on earth, and tannin iron (Fe-TA), derived from [tannic acid](#) (TA) and iron (Fe) obtained from plants. By changing the size of the [fine particles](#) composed of silica and iron tannate, the resulting color can be changed. In addition, the angular dependence of the resulting color can be reduced by changing the aggregate state of the particles. In addition, the presence of TA increases the mechanical stability of the [pigment](#) and improves its adhesion to the glass substrate, making it suitable for coating applications.

The lead author says "In our daily lives, pigments and dyes that absorb part of the visible spectrum and scatter or transmit other colors of light

are widely used. However, the [natural world](#) contains not only pigments and dyes of this kind, but also structurally colored materials, which display vivid colors because of the interaction of their fine structure with light. Considering that, there is no doubt that the safe and inexpensive structurally colored pigments introduced in this study will be useful for everyday life."

Structurally colored materials can display various colors based on the principle of the three primary colors of light. In addition, materials whose colors do not depend on the viewing angle can be prepared. In the future, the group expects that research on structurally colored materials will result in the development of safe and inexpensive colorants.



Figure 2: A colored diagram obtained by spraying FeCl_3 aqueous solution (10 mg/mL) onto the whitish sheet via a mask and drying. Credit: Nagoya University

More information: Miki Sakai et al. Colorful Photonic Pigments Prepared by Using Safe Black and White Materials, *ACS Sustainable Chemistry & Engineering* (2019). [DOI: 10.1021/acssuschemeng.9b03165](https://doi.org/10.1021/acssuschemeng.9b03165)

Provided by Nagoya University

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