advances in technology

Hungary 5000 BC

Athens 500 BC

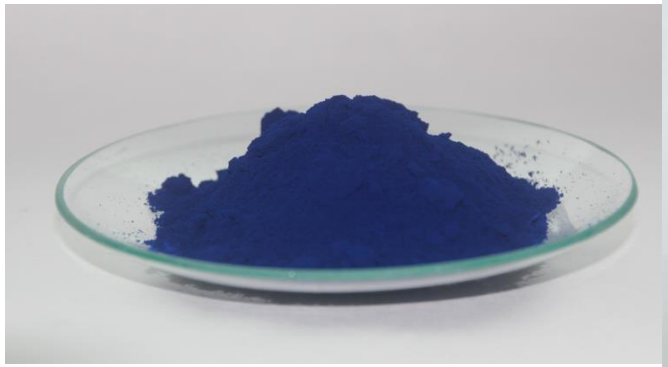
China 200 BC

UK
1780

US
1980

brightly colored, glazed majolica

Synthesis of Prussian Blue pigment



+3 +2 +3 +2

$FeCl_3(aq)$ + $K_4Fe(CN)_6(aq)$ -> $KFe[Fe(CN)_6](s)$

soluble *soluble* *insoluble*

+ 3 KCl(aq) *soluble*

minerals (ores): Fe_2O_3 TiO_2

Colors of representative compounds of the Period 4 transition metals.

pigments available for ceramics http://www.earthpigments.com/oxide-pigments/

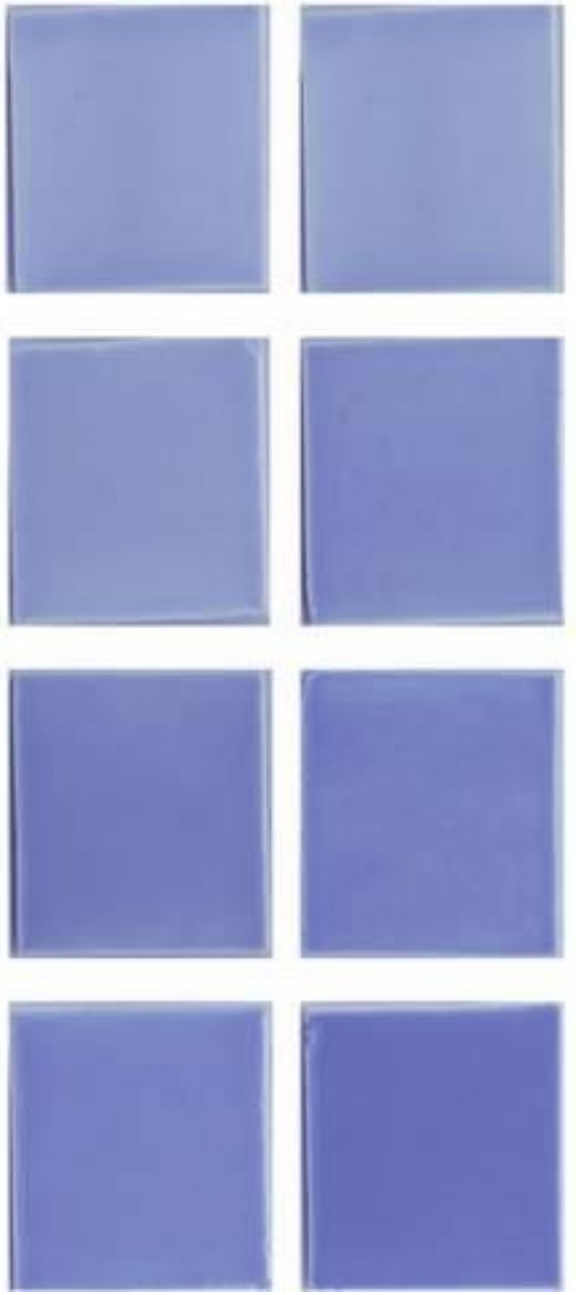
A new vibrant blue pottery pigment with less cobalt

American Chemical Society PressPacs February 22, 2024

Many of the brilliant blue pigments — like those in antique Chinese porcelain or works by Claude Monet — make use of cobalt-based compounds, including the famous “cobalt blue.” Though the metal itself is toxic, in mineral form it has high chemical and thermal stability, and those properties make cobalt aluminate one of the only pigments suitable for high-temperature applications, including pottery glazes. Today, cobalt is used in lithium-ion batteries, and demand for the metal ore will likely increase as the need for battery power grows. As a result, scientists including Peng Jiang and colleagues are searching for alternative pigments that require fewer cobalt ions and still maintain a bright blue hue.

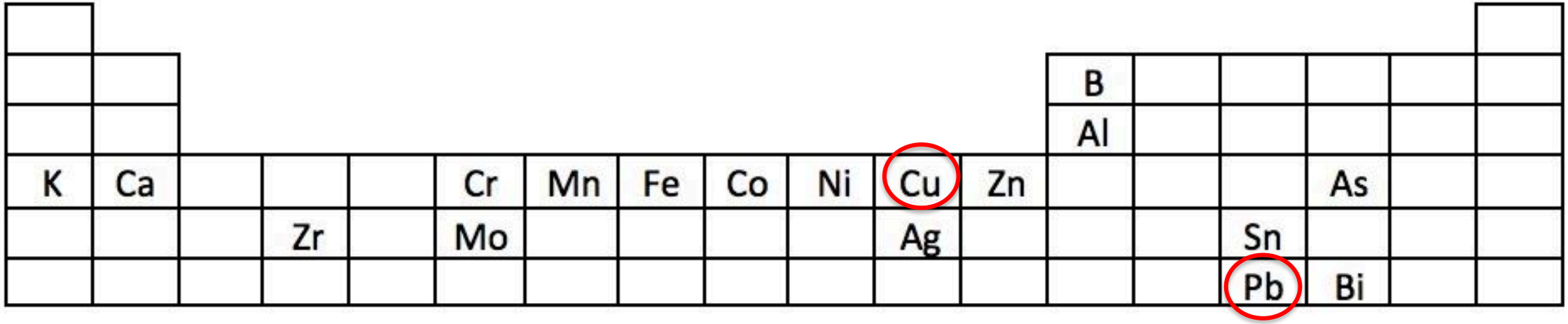
Compounds containing barium, aluminum, silicon and cobalt were ground together, pressed into a sheet, then heated to above 2550°F to form the pigment. Then the researchers mixed the powder into a ceramic glaze, sprayed it onto tiles and fired them to produce glazed pieces of pottery. The pigment was stable at temperatures up to 3200 degrees — well above the typical firing temperature of a pottery kiln — and only experienced slight color changes when exposed to either acidic or alkaline solutions, demonstrating the compound’s stability. The researchers say that this new powder substantially reduces the amount of cobalt needed, resulting in a cheaper, easier-to-produce blue ceramic pigment.

The authors acknowledge funding from the Beijing Nova Program, the Fundamental Research Funds for the Central Universities, the Youth Teacher International Exchange & Growth Program, and the National Science Foundation.



ACS Applied Optical Materials 2024,
DOI: 10.1021/acsaom.3c00419

Macherey-Nagel rapid test kit availability (from CTL)



Tests for metal ions in glazes

test strips

Cu: pink
Pb: no change

Cu: pink
Pb: pink

Cu: no change
Pb: no change

X-Ray Fluorescence (XRF)

cup	dog	tiger
S, Cu, Zn	S, Pb, Cu	Si, Ca, Pb, Zn, K, Ir, Fe, Zr, Mn, Cr, Th, Cu

V&A Wedgwood Collection

Wednesday – Sunday: 10.00 – 17.00

Admission is free

Wedgwood Drive, Barlaston,
Stoke-on-Trent ST12 9ER

Staffordshire potter and entrepreneur **Josiah Wedgwood** (1730 – 95) was a pioneering tastemaker, marketeer and social campaigner. In 1759, Josiah founded his ceramics company which achieved global success and remains in production today. Designs and wares saved by the factory and Wedgwood family grew into one of the most important industrial collections in the world.

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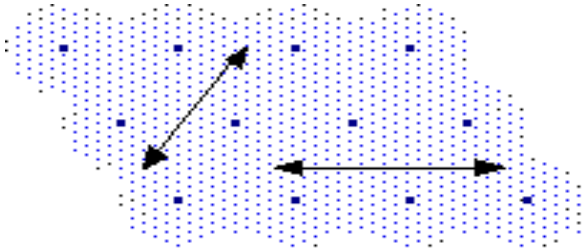
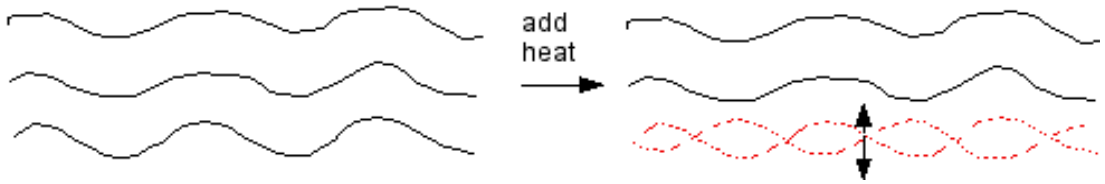
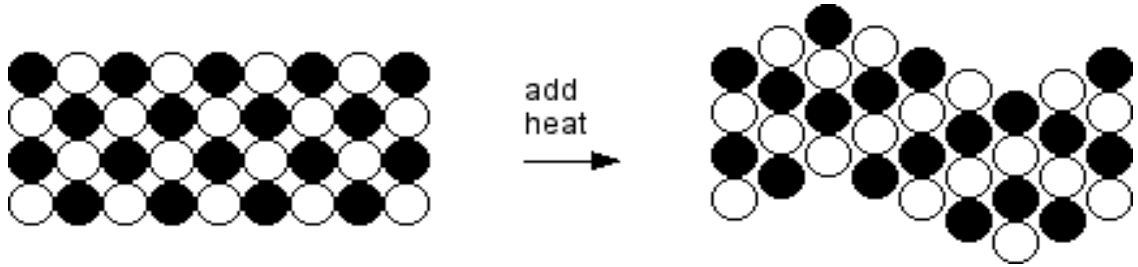
conduction of heat by different classes of materials



metal: valence electrons
use heat to move quickly
through sea of nuclei



polymer: heated chains can vibrate;
weak (secondary) bonds to neighbors,
so vibration won't propagate



ceramic: ions strongly bonded, move together if enough energy;
limited ability to vibrate before cracking

Space Shuttle Thermal Protection

There are 24,300 tiles that measure about 6 inches long on each side and vary in thickness from 1 to 5 inches depending on where they are attached.

The shuttle tile is made of a **porous** material which is a silica, alumina fiber and borosilicate glass composite. It is very light and extremely heat resistant.

Black-coated tiles that can withstand up to 1260° C cover the bottom of the shuttle, areas around the forward windows, and several other key areas.

White-coated tiles insulate the shuttle up to 650°C. These tiles are larger and thinner, 8 inches long on each side and from less than a half inch thick up to 1 inch in thickness.

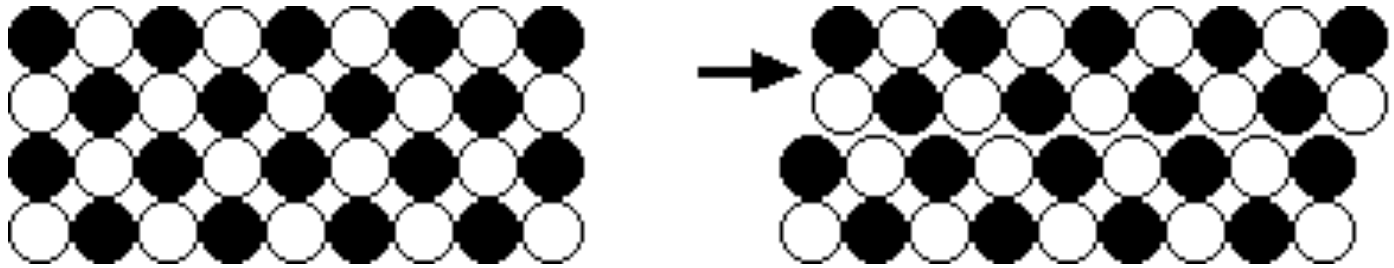


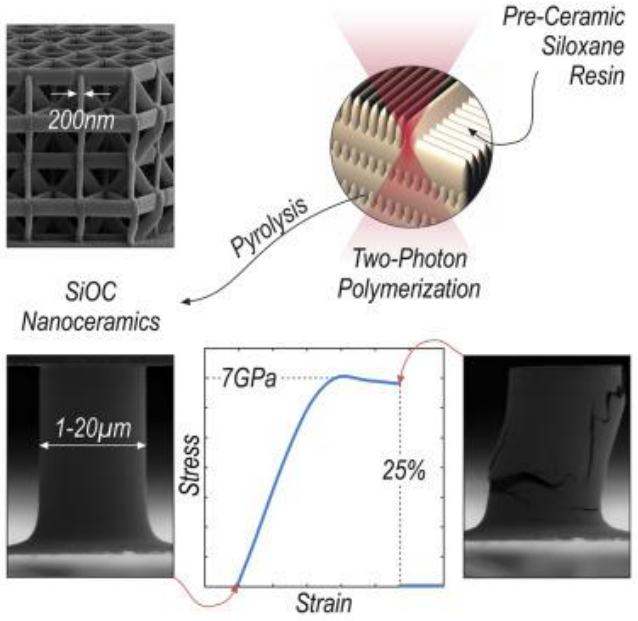
Figure 2.10 slipping in ionic crystal

Kintsugi: The Art of Broken Pieces

Urushi Lacquer, gold powder

3-D printing superstrong ceramics

Chemical & Engineering News October 14, 2019



Ceramics like your humble coffee mug are stiff, lightweight, and heat resistant. But they're also brittle.

To overcome this weakness, researchers have now used 3-D printing to create ceramics that are both **strong and ductile** (*Matter* 2019, DOI:10.1016/j.matt.2019.09.009). Such materials could eventually be used in engineering applications, such as in airplane engine components.

Traditional methods for making ceramic objects use pressure and heat to fuse inorganic powders together, but these processes tend to create tiny pores and that quickly turn into larger breaks when the material is stressed. Lorenzo Valdevit at the University of California, Irvine, says 3-D printing offers a way to build ceramics without those fatal flaws.

To make the new ceramics, he and his team mixed (**mercaptopropyl)methylsiloxane** and **vinylmethoxysiloxane** with a phosphine oxide reagent. Exposed to pulses of infrared laser light, this reagent forms a radical that triggers the siloxanes to polymerize, creating a solid. Crucially, the radical forms only when and where two photons of infrared light arrive simultaneously, which confines the polymerization to the intense focal point of the laser. After washing away unreacted siloxanes, the researchers heated their polymer structures at 1,000 °C for 1 h to force out any organic components, **leaving only silicon, oxygen, and carbon atoms**.

The team used this approach to create ceramic pillars up to 20 μm wide and complex lattices—known as architected materials—with struts up to 600 nm wide. The precision of two-photon laser writing enabled the new lattices to be the stiffest and strongest architected materials ever made, the researchers contend. —MARK PEPLOW

archaeological digs

Hungary, 5th century BCE

Shells, Bones, Pottery Sherds
appear to be eroding out of a prehistoric garbage heap, or "midden."

Tuscon, 20th century CE

<u>contents</u>
- food
- yard waste
- hazardous waste
- plastic

biodegradable materials
- did not biodegrade

<u>influenced by</u>
- market conditions
- economic class
- government actions