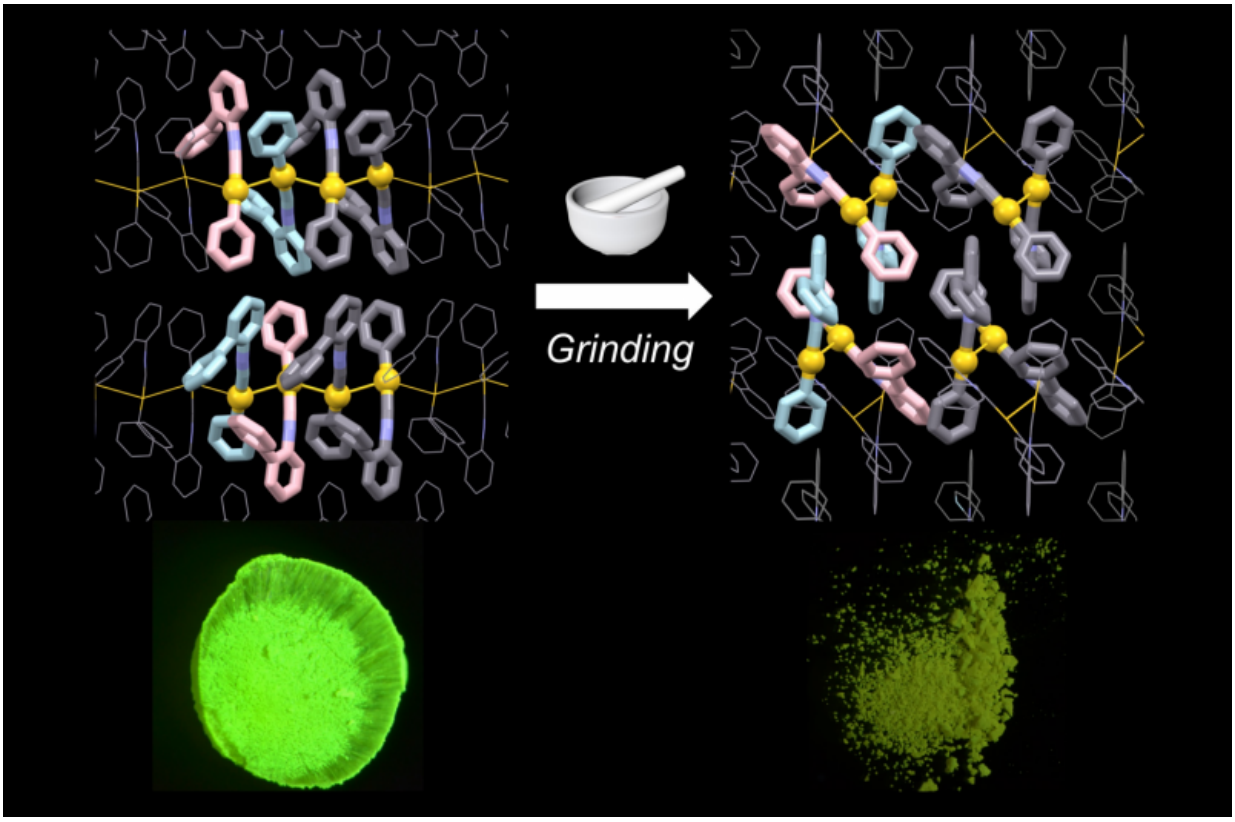
New strategy to design mechano-responsive luminescent materials

July 25 2017



Grinding chiral crystals of gold and isocyanide complexes caused them to transition into achiral crystals while simultaneously changing their emission properties. Credit: Hokkaido University

Crystals made from gold complexes change color as they change structure from "chiral" to "achiral" when ground.

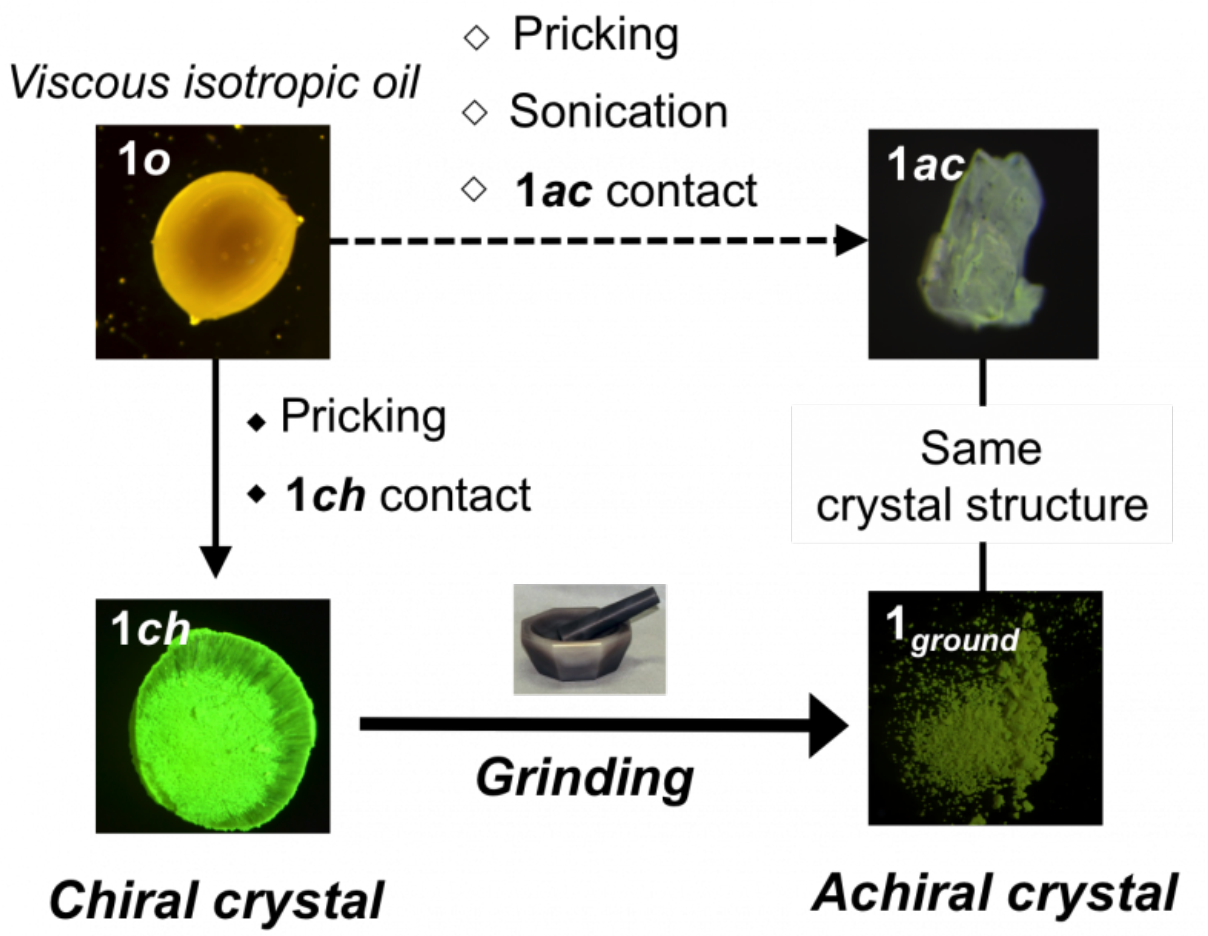
"Smart" materials that change color in response to a mechanical stimulus have a broad range of applications such as creating pressure-sensitive sensors and packaging that can detect tampering.

Researchers at Hokkaido University have now designed a novel "mechano-responsive luminescent material" using a gold and isocyanide complex, which includes two bonded rings of carbon and hydrogen atoms.

When the material is first prepared, it is a viscous oil. The oil emits an orange color under ultraviolet irradiation. When the oil is pricked with a needle, however, it randomly crystallizes either into "chiral" yellow crystals that emit green light or into "achiral" whitish-grey crystals that emit bluish-green light.

A crystal is chiral if the molecules are aligned in a way it cannot be superimposed onto its mirror image. This makes your left and right hands chiral, for example, while a soda pop can would be achiral.

The oil also transformed either into chiral or achiral crystals when in contact with small pieces of each crystal respectively. Furthermore, when ultrasonic was applied to the oil for 20 minutes, it turned into a powder of the achiral crystals.



Viscous oil made from gold and isocyanide crystalizes in response to stimuli either into a chiral crystal or achiral crystal. A chiral crystal turns to an achiral crystal when ground. Phase transitions cause color changes. Credit: Jin M. et al., Journal of the American Chemical Society, May 23, 2017

Remarkably, grinding chiral crystals caused them to transition into achiral crystals while simultaneously changing their emission properties. "This is the first proof that the chiral-to-achiral phase transition caused by a mechanical stimulus could alter emission properties," says Hajime Ito, the corresponding author of the study published in the *Journal of the American Chemical Society*. "Achiral crystals are generally more stable

than chiral crystals, known as Wallach's Rule. This makes the chiral-to-achiral transition very reasonable."

This is the first such example of this kind of material, they say, and their results indicate that the dynamic change between the two crystal phases may be a promising strategy to design universal mechano-responsive functional materials. "By targeting molecules that can form both chiral and achiral crystals and follow Wallach's Rule, we might be able to develop mechano-responsible materials more strategically and efficiently," Ito added.

More information: Mingoo Jin et al. Mechano-Responsive Luminescence via Crystal-to-Crystal Phase Transitions between Chiral and Non-Chiral Space Groups, *Journal of the American Chemical Society* (2017). DOI: 10.1021/jacs.7b04073

Provided by Hokkaido University