Photolithography, Energy storage, Sensor

Organic crystal melts under light with luminescence evolution

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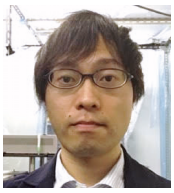

Abstract

Researchers at Graduate School of Science and Engineering Science discovered a new class of photo-responsive crystal compounds, heteroaromatic 1,2-diketones. Certain light irradiation causes the crystals in these materials to melt, dramatically changing the materials' properties. One member of this class, SO, shows luminescent changes while melting, which enabled the research team to visualize the crystal-melting process at the molecular level. These findings provide fundamental insights into the mechanisms behind crystal melting and will enable future designs of light-responsive materials.

Background & Results

While many materials melt when heated, Komura, Sotome, Tani and colleagues recently discovered a novel material in which melting is not caused by heat, but by ultraviolet light. Even more intriguing, this material changes luminescent color while it melts. This material is the first organic crystalline material found to show changes in luminescence color upon ultraviolet light-induced melting.

In *Chemical Science*, they reported their discovery of a new class of photo-responsive crystal compounds, 'heteroaromatic 1,2-diketones'. Light irradiation causes the crystals in these materials to melt, a phenomenon termed photo-induced crystal-to-liquid transition (PCLT). This phenomenon can dramatically change material's properties and makes possible a broad range of applications, for example, photo-responsive, reversible adhesives that could be controlled by light. Few materials have been shown to have this crystal-melting property; hence, the discovery of a new class of PCLT materials is a great step forward in this field.

In characterizing their newly discovered class of PCLT materials, the researchers found that one member of this class, the diketone 'SO', shows changes in luminescence during the irradiation-induced melting process. This is the first organic crystal that exhibits a luminescent evolution during crystal melting, showing changes in intensity and color, from green to yellow. Based on these changes in luminescence, as well as single-crystal X-ray analysis, thermal analysis, and theoretical calculations, the researchers demonstrated that SO was undergoing molecular conformational changes during the PCLT process, and a disordered layer in the crystal is a key factor for the conformational change in this class of materials.

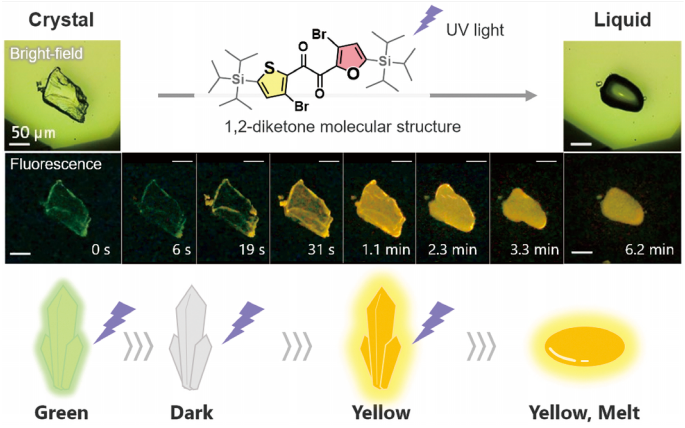

Fig. 1 Photo-induced crystal melting with luminescence evolution

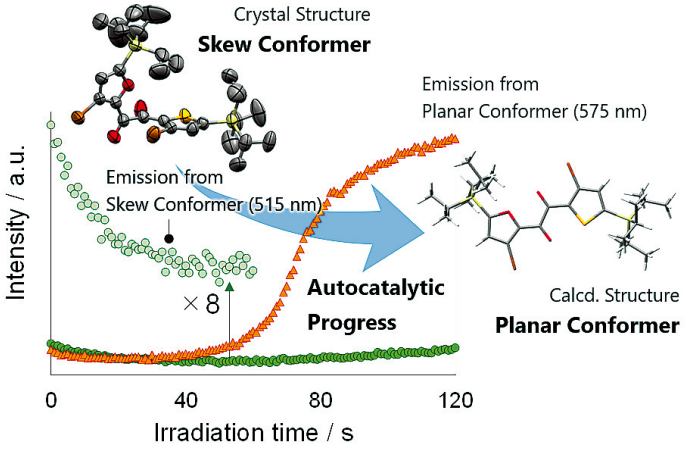

Fig. 2 Autocatalytic conformation change

Significance of the research and Future perspective

This discovery of a novel PCLT material, along with its characterization, provides fundamental insights into the mechanism of crystal melting and will enable greater opportunities for designing PCLT materials with a variety of applications, including photolithography, thermal energy storage, and light-induced adhesion.

Patent

Treatise
Komura, Mao; Sotome, Hikaru; Tani, Yosuke et al. Photoinduced crystal melting with luminescence evolution based on conformational isomerization. Chem. Sci. 2023, 14, 5302–5308. doi: 10.1039/D3SC00838J
Komura, Mao; Ogawa, Takuji; Tani, Yosuke. Room-temperature phosphorescence of a supercooled liquid: kinetic stabilisation by desymmetrisation. Chem. Sci. 2021, 12, 14363–14368. doi: 10.1039/D1SC03800a
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URL

Keyword chemistry, organic crystal, light, stimulus-responsive materials