# High-speed bending and the simulation of anisole crystals based on photothermal effect and natural vibration

([1]*Waseda University*, [2]*AIST*, [3]*Tokyo Institute of Technology*) ○ Yuki Hagiwara,[1] Shodai Hasebe,[1] Meguya Ryu,[2] Hiroki Fujisawa,[3] Junko Morikawa,[3] Toru Asahi,[1] Hideko Koshima[1]
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Mechanical crystals are expected to be applicable to actuators and soft robots.[1] Over the past decade, we have reported many mechanical crystals based on photoisomerization[2] and phase transition.[3] Recently, we discovered the fast crystal bending by the photothermal effect,[4] and then we proved this bending mechanism based on the non-steady heat conduction.[5] In this research, we investigated the 2,4-dinitroanisole (**24DNAN**, Figure 1a) crystals with the large thermal elongation[6] for creating large photothermally driven bending, and unexpectedly we have found the high-speed bending by the natural vibration.

The rod-shaped **24DNAN** crystals were obtained by fast cooling of methanol solution. The thermal expansion coefficient along the length direction (*a*-axis) exhibited a relatively large of 247 $MK^{-1}$. When the rod-shaped crystal (length: 6,075 μm, width: 151 μm, thickness: 105 μm, Figure 1b) was irradiated with UV laser (375 nm), the crystal bend down largely and quickly by 0.85° in 9 ms, and then gradually bent by 1.2° by the photothermal effect, accompanied with the weak natural vibration of 390 Hz (black, Figure 1c). Upon pulsed UV laser irradiation at the same frequency as the natural frequency, the high-speed bending of 390 Hz was amplified to 2.3° by resonance (Figure 1d). Finally, the bending simulation using the finite element analysis was succeeded to reproduce the measured bending by the photothermal effect and the natural vibration (red, Figure 1c).

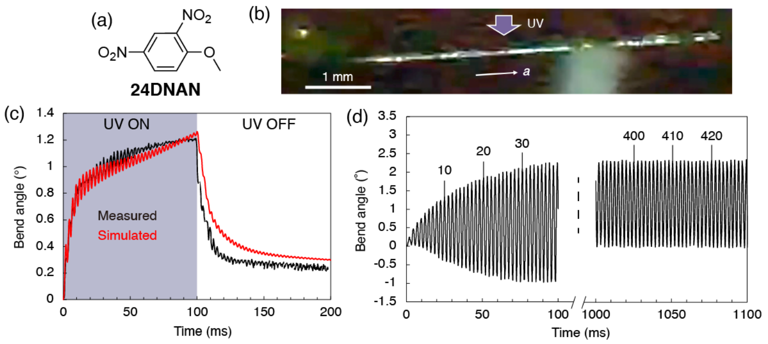


**Figure 1** (a) Molecular structure of **24DNAN**, (b) the rod-shaped **24DNAN** crystal, (c) time profiles of the photothermally driven bending; measured (black) and simulated (red) bend angle, (d) high-speed bending of 390 Hz.

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