

## Ultrafast, light, soft martensitic materials

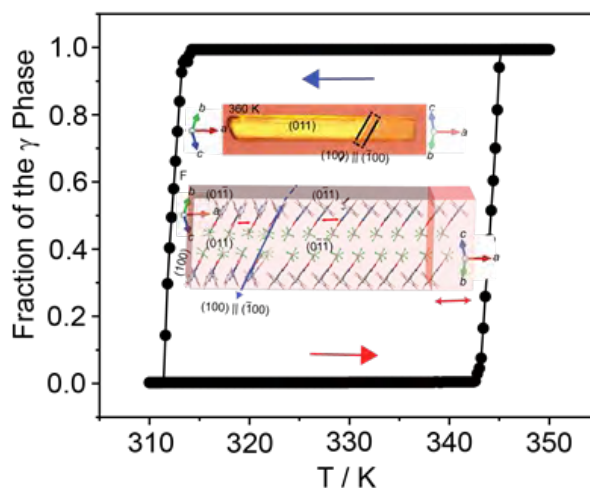
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Martensitic transformations are well documented in metals and alloys where the atoms connected via metallic bonds rearrange concertedly and rapidly; however, due to the metal atoms, these materials are inherently very dense and add significant weight and bulkiness to actuating devices. Here, remarkably rapid lattice switching of molecular martensitic materials is reported in crystals of (phenylazophenyl)palladium hexafluoroacetylacetonate (PHA) and L-pyroglutamic acid (L-PGA) where the rate of structural transformation exceeds other phase transitions several orders of magnitude [1,2]. With a determined speed in the range of 0.3–0.6 m s<sup>-1</sup>, the new phase advances throughout the crystal about ten thousand times faster relative to spin-crossover transitions, and about hundred to hundred thousand times faster than other common structural phase transitions. Macroscopic crystals of these materials respond by rapid expansion or contraction of about 0.02 m s<sup>-1</sup> for unrestrained crystals and 0.02–0.03 m s<sup>-1</sup> for clamped crystals. Monte–Carlo simulation of the spatiotemporal profile of the transition and of the local distribution of elastic and kinetic energies induced by domain growth reveals the critical role of the dynamic phase boundary and the lattice edges in the structure switching. Within a broader context, this study indicates that the martensitic organic crystals are prospective lightweight substitutes of metals for ultrafast and clean energy transduction.



**Figure 1.** Thermosalient transition in PHA crystals simulated by the Monte–Carlo method ( $n_\gamma$  denotes the fraction of the cells that are in the  $\gamma$ PHA phase).

### References:

- [1] Ahmed, E., Karothu, D. P., Slimani, A., Halabi, J. M., Tahir, I., Canales, K. Q. & Naumov, P. (2022). *Adv. Funct. Mater.*, **32**, 2112117.
- [2] Park, S. K. & Diao, Y. (2020). *Chem. Soc. Rev.*, **49**, 8287.