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Design of elastically bendable molecular crystals: Implications for smart actuators

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Imparting both flexibility and crystallinity in organic solids pose a great challenge because it defies the common perception of brittle nature of organic crystals. Mechanical properties of molecular crystals are less explored by scientific community though it has a wide array of applications including optoelectronics, mechanical actuators, artificial muscles etc.[1] Recently, Ghosh and Reddy demonstrated first example of excellent shape recovery of elastic bendable co-crystal solvate of caffeine-4-chloro-3-nitrobenzoic acid.[2] This behaviour is attributed to interlocked host structure with weak and dispersive interactions in all three directions. There was no design strategy yet even after this serendipitious discovery. Later Ghosh et al. addressed this through designing a series of seven halogenated N-benzylidineanilines crystals.[3a] It has been observed that following two features are mainly responsible: 1) Presence of weak and dispersive interactions including peripheral halogen bonds that can act as structural buffers for easy breakage and reformation during bending. 2) interlocked corrugated pattern which prevents easy slippage of molecular planes. The crystals are highly flexible and even when it breaks down in two pieces, individual pieces show excellent shape recovery indicating its self-healing nature. Also, there is recent report of dual stress and thermally driven mechanical properties of same organic crystal 2,6-dichlorobenzylidine-4-fluoro-3-nitroaniline.[3b] Two properties are not related to each other and arise from simultaneous isotropy and anisotropy in crystal packing. These materials have immense potential for smart hybrid actuating devices in future.

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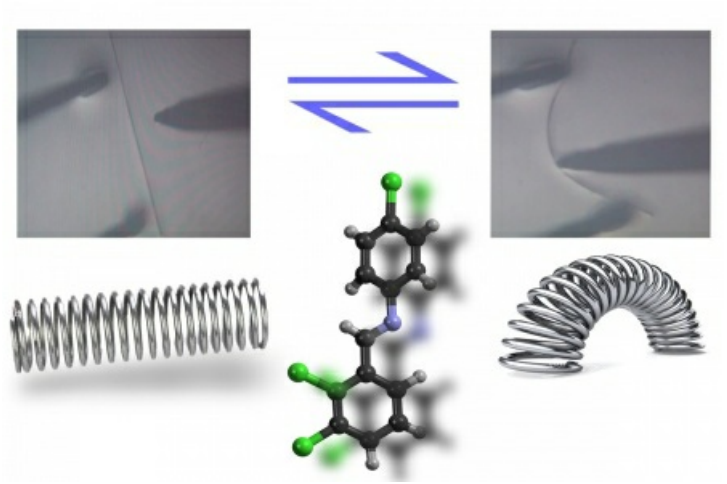
[2] Ghosh, S. & Reddy, C. M. (2012). Angew. Chem. Int. Ed. 124, 10465-10469.
[3] a) Ghosh, S. et al. (2015). Angew. Chem. Int. Ed. 54, 2674-2678. b) Ghosh, S. et al. (2015). J. Am. Chem. Soc. 137, 9912-9921.



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