

Metal-like ductility and malleability in organic plastic crystals

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Ductility, which is a common phenomenon in many metals, is difficult to achieve in molecular crystals. Organic crystals have been recently shown to bend plastically on one or two face specific directions, but they fracture when stressed in any other arbitrary directions.^[1] Here, we present an exceptional metal-like ductility and malleability in the isomorphous crystals of two globular molecules, BH_3NMe_3 and BF_3NMe_3 , with characteristic tensile stretching, compression, twisting and thinning (increase of width over 500%).^[2] Surprisingly, the mechanically deformed samples, which transition to lower symmetry phases, not only retain good long range order, but also allow structure determination by single crystal X-ray diffraction. Molecules in these high symmetry crystals interact predominantly via electrostatic forces ($\text{B}^- \text{N}^+$) and form columnar structures, thus forming multiple slip planes with weak dispersive forces among columns. While the former interactions hold molecules together, the latter facilitate exceptional ductility. On the other hand, the limited number of facile slip planes and strong dihydrogen bonding in BH_3NHMe_2 negates ductility. The structure-property correlation established in these aminoboranes with exceptional ductility and ability to retain crystalline order may enable designing highly modular, easy-to-cast crystalline functional organics, for applications in solid-state electrolytes, adaptable electronics^[3] (soft ferro/piezo/pyro-electrics), barocalorimetry (solid coolants),^[4] soft-robotics etc.^[5]

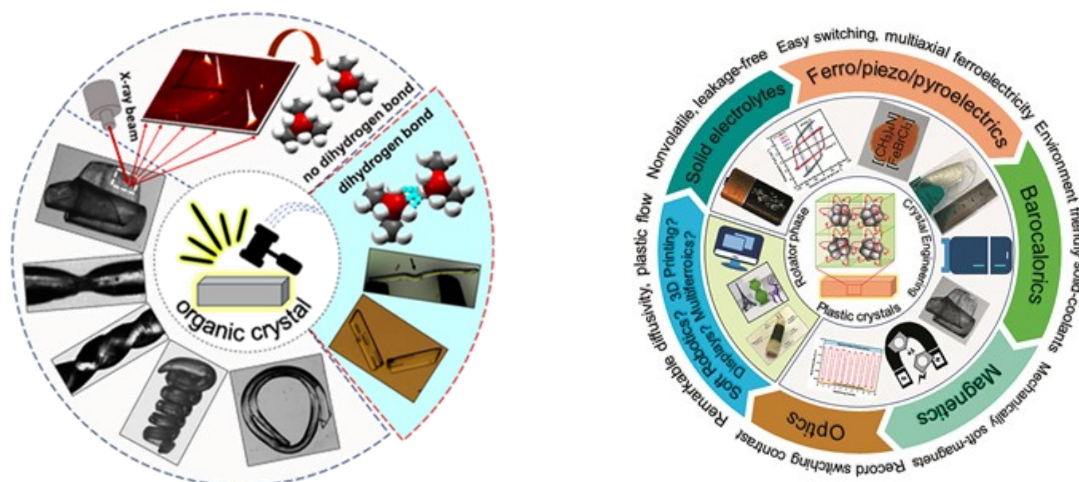


Figure 1. [Left] Peculiar mechanical properties of BR_3NMe_3 ($\text{R} = \text{H}, \text{F}$) which show metal like ductility & malleability along with X-ray diffraction from mechanically yielded thin film and 1D plasticity in BH_3NMe_3 due to presence of dihydrogen bonding. [Right] Emerging applications of plastic crystals in diverse fields like solid-state electrolytes, barocalorimetry, adaptable electronics etc.

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