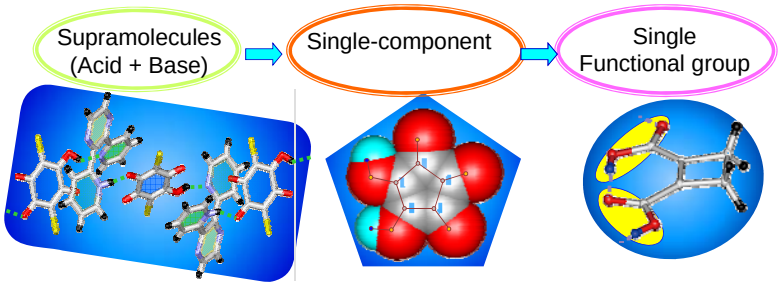
Materials Development and Structural Studies of Organic Ferroelectrics

Sachio Horiuchi [1,2]
[1]Flexible Electronics Research Center, National Institute of Advance Industrial Science and Technology (AIST), Tsukuba, 305-8562, Japan
[2]CREST, Japan Science and Technology Agency (JST), Tokyo, 102-0075, Japan

In ferroelectrics, spontaneous polarization can be reversed by applying electric field. This principle as well as its related functionalities has been used in data storage, capacitor, thermal sensors, piezoelectric devices, and optical devices. In spite of their potential, there were very few examples of organic ferroelectrics until our recent approach with hydrogen bonding between acid and base has materialized more than 10 supramolecular ferroelectrics [1]. These supramolecules were mostly obtained as linear-chain hydrogen-bonded cocrystals of 2,5-dihydroxy-*p*-benzoquinones (H_2xa) with various bases such as phenazine (Phz) and 2,2'-bipyridine derivatives. We found various mechanisms for ferroelectricity such as displacement and collective transfer of protons depending on the nature of hydrogen bonds.



Later on, we successfully discovered the electric polarization - field hysteresis on single-component molecular crystals with β-diketone enol O=C−C=C−OH or carboxylic unit; croconic acid ($C_5H_2O_5$) [2], cyclobutene-1,2-dicarboxylic acid, 2-phenylmalondialdehyde, and 3-hydroxyphenalenone [3]. Proton tautomerism, which can switch the polarity of a hydrogen-bonding chain, has been proved to functionalize the ferroelectricity of high polarization performance at room temperature. The mechanism is rather irrespective of the details of local bonding configurations, and then this design principle is not limited to the specific molecules as demonstrated here but could be adaptive to diverse class of materials even including polymeric and biomolecular systems.

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