A new multiaxial molecular ferroelectric displays giant d_{33} comparable to BTO

Subject Code: A04

With the support by the National Natural Science Foundation of China, the research team led by Prof. You Yumeng (游雨蒙) and Prof. Xiong Rengen (熊仁根) at Ordered Matter Science Research Center, Southeast University, Nanjing, recently reported their collaborative study on a new molecular ferroelectric with unprecedented piezoelectric constant d_{33} of 185 pC/N, which was published in *Science* (2017, 357: 306—309).

Piezoelectric effect plays an irreplaceable role in the modern society and has been widely utilized in various aspects. Nowadays, with the development of piezoelectric effect moving towards applications of thin-films, coating, flexible devices, micromechanics and biomechanics, conventional inorganic piezoceramics are facing great challenges. In spite of excellent piezoelectric properties [for example, piezoresponse coefficient d_{33} of mono-composition BTO is 190 pC/N], inorganic piezoceramics suffer from high processing-temperature, high cost on large-area-film-processing, structural rigidity and potential toxic composition (such as lead). Emergent of molecular ferroelectrics (MFE) seems to provide a glimpse of hope in solving this problem, since ferroelectricity has been proven to be closely related to good piezoelectric performance and molecular ferroelectrics possess advantages like simple solution-processing, mechanical flexibility, soft, light-weight and easy property-tuning, inherited from molecular materials. Unfortunately, the piezoresponse of MFEs is still order of magnitude behind that of inorganics. For example, to their best knowledge, the highest piezoresponse coefficient of MFE was found on imidazolium perchlorate by their group, with $d_{33}=41$ pC/N [*Angew Chem Int Ed*, 10.1002/anie.20140348 (2014)], while most other MFEs have $d_{33}<30$ pC/N.

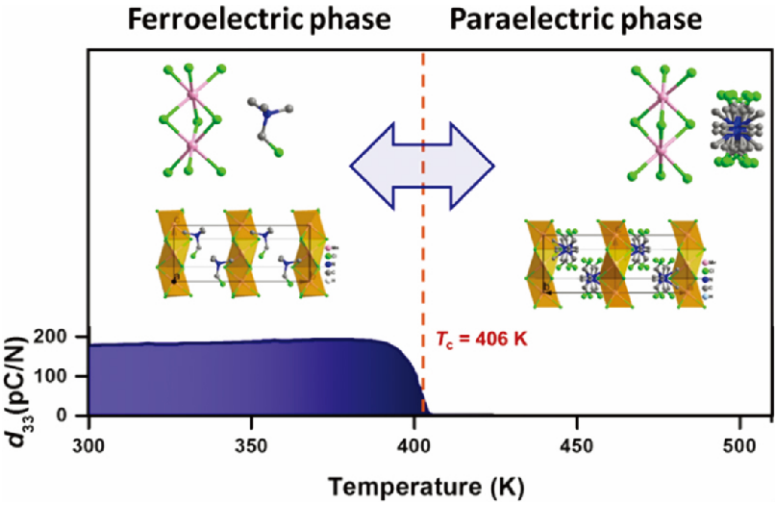

Figure Illustration of the crystal structure and piezoelectric coefficient d_{33} of TMCM-MnCl3 at different temperature.

In their recent work, they present an organic-inorganic hybrid perovskite-like ferroelectric, trimethylchloromethyl ammonium trichloromanganese(II) [$Me_3NCH_2ClMnCl_3$, (TMCM-$MnCl_3$)], with extraordinarily huge piezoresponse coefficient of $d_{33}=185$ pC/N. This is the largest reported d_{33} on molecular material, and TMCM-$MnCl_3$ is also the first molecular piezoelectrics approximating BTO ($d_{33}=190$ pC/N) since the discovery of piezoelectric effect 136 years ago. The piezoelectric and ferroelectric properties of TMCM-$MnCl_3$ were characterized by both macroscopic and microscopic methods on the single crystal and thin-film samples. Combining the large d_{33}, decent ferroelectric property, near unity photoluminescence efficiency and advantages inherited from hybrid materials, TMCM-$MnCl_3$ would be a great candidate for next generation materials in applications like flexible devices, wearable power-generation, micromechanics, bionics, etc.