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Dr. Tim Usher

California State University - San Bernardino

A New Organic Ferroelectric

The recent discovery* of a strong ferroelectric response in single crystal croconic acid has the potential to advance the current understanding of organic ferroelectrics as well as open up new applications for organic chemistry. The room temperature spontaneous polarization, P_s = 26 μC/cm^{-2} is comparable to inorganic ferroelectrics. The structure of croconic acid, or 4,5-dihydroxycyclopentenetrione ($C_5H_2O_5$) consists of a five sided carbon ring with an oxygen atom bonded to each oxygen atom. Two hydrogen atoms are bonded to two of the oxygen atoms. Croconic acid is a member of the cyclic oxocarbon acids: deltic acid, squaric acid, croconic acid**,** and rhodizonic acid. As the names imply, they are three, four, five and six sided ring structures. The piezoelectric properties of croconic acid have not been reported. Squaric acid is already known to be antiferroelectric in crystalline form. However, other forms, in particular thin films, have not been investigated. Even less has been reported about the dielectric/ferroelectric/piezoelectric properties of deltic and rhodizonic acids. These new organic ferroelelctrics could provide a sensitive proving ground for the accuracy of first principle models. In return, powerful organic chemistry design tools, knowledge, and techniques can be leveraged to engineer new ferroelectric materials. An adequate understanding of these new organic ferroelctrics could lead to the engineering of simple organic molecules into useful ferroelectric/piezoelectric materials. Furthermore, new economic incentives from applications would potentially provide additional motivation for further theoretical advances. In addition to more standard characterizations such as hysteresis loop measurements, electron paramagnetic resonance (epr) techniques that have been successfully employed in studying inorganic ferroelectrics are being brought to bear on these organic ferroelectrics for the first time.

* Horiuchi S.l, Tokunaga Y., Giovannetti G. , Picozzi S., Itoh H., Shimano R.,Kumai R and Tokura Y. “Above-room-temperature ferroelectricity in a single-component molecular crystal.” *Nature*, Vol. 463, 789-792 (2010).

Wednesday, September 7, 2011
3:30 pm - Room 151, Jorgensen Hall

Host:
Dr. Stephen Ducharme
Department of
Physics & Astronomy

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