

What is So Interesting about Antiferroelectrics: A Walk in Lesser-Known Footsteps of Prof. Eric Cross

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The rich legacy Prof. Eric Cross left us includes numerous examples of transformations of abstract theories into meaningful concepts and useful materials and devices. He has done this over and over again, in electrostriction, relaxors, flexoelectricity, and much more.

Among the wealth of subjects Prof. Cross ignited and drove, that of antiferroelectricity was somewhat overlooked. Indeed, antiferroelectricity and antiferroelectrics have not yet delivered their promise; but, has the last word been said already?

The work of Eric Cross on antiferroelectricity and antiferroelectrics has spanned half a decade from the early days of antiferroelectricity when he expanded Kittel and Devonshire theory on antiferroelectrics to three dimensions, making it directly applicable to real materials and applying it to sodium niobate and KTN^{1,2}, till recent years where he introduced them into applications including, e.g. micromotors.³

While antiferroelectric phase is widely considered an antipolar phase whose free energy is comparable to that of a ferroelectric phase of the same material, Prof. Cross emphasized an additional aspect: “It is recognized that the dielectric anomalies at the phase change in these crystals are a characteristic of what would be a lower temperature ferroelectric form which has been frustrated by the slightly more stable antipolar arrangement occurring first”.^{4,5} In other words, an antiferroelectric is an ‘inhibited ferroelectric’.⁶ Conceiving antiferroelectrics this way leads to new insights: For example, the antiphase boundaries in antiferroelectrics can carry ferroelectricity as shown recently⁷, because the antipolar phase itself is frustrated at its anti-phase boundaries.

Will this lead to new ways of using antiferroelectrics? And, could antiferroelectrics find applications in the realization of new devices such as the much sought after negative capacitors⁸ or ferroic-based photovoltaics⁹? The future will tell.

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