**Microfields Induced by Random Compensated Charge Pairs in Ferroelectric Materials**

Frank J. Crowne
RF Electronics Division, Army Research Laboratory,
Adelphi, MD 20783-1197, U.S.A.

## ABSTRACT

The dc and microwave responses of materials that undergo phase transitions, for example, ferroelectric and ferromagnetic materials, are of great interest to device physicists. However, they usually are available in ceramic form only, which requires a mathematical description that goes beyond the single-crystal approximation used to address most solid-state problems. I will discuss how random-field techniques can be used with the mean-field (Landau-Devonshire) theory of ferroelectricity to compute the dielectric constant of a material with randomly-located impurity sources of random electric fields. The sources of these fields are assumed to be permanent dipoles made up of pairs of positive and negative ions separated by a few lattice constants. I show that whereas completely random placement of positive and negative ions generates a Holtsmark electric field distribution, with infinite second moment and hence extremely large fluctuations in field strength, the association of ionized impurities into permanent dipoles leads to a squared-Lorentzian distribution with much lower fluctuations in field, although still lacking a finite second moment. The infinite moments prohibit a description based on the central-limit theorem. Use of more microscopic models such as the transverse-Ising model will also be discussed.