

Elaboration and characterization of molecular lead free ferroelectrics

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DabcoHBF₄ is a lead free ferroelectric material synthesized from commercial tetrafluoroborate acid (HBF₄) and DABCO (1,4 diazabicyclo[2.2.2]octane). It shows room-temperature ferroelectricity with a Curie temperature of 107°C at which a great permittivity jump (multiplied by 2 to 5) is witnessed.

This material has already been deeply studied from a crystallographic point of view but its dielectric and piezo-electric components are still to be explored. As a first step, in a recent study, we analyzed the influence of various parameters (frequency, heating rate, pellet molding pressure) on the dielectric response of polycrystalline dabcoHBF₄ powder shaped in pellets, which work is to be continued here.

Piezoelectric characteristics on dabcoHBF₄ polycrystals in the room-temperature phase are not investigated in depth up to now. Thus, one purpose of our present work is to increment this analysis to imagine a substitute to lead-containing ferroelectrics as PZT (Lead zirconate titanate).

Alongside, dielectric properties (permittivity, losses, conductivity) measurements on a large range of temperatures (200K to 450K) and frequencies (0.01 Hz to 1 MHz) are in progress. Based on frequency-temperature coupled conductivity measurements, we will discuss the intrinsic charge transport mechanisms of the material and its conductivity values in relation to the potential applications of these ferroelectric materials.

To increase dabcoHBF₄ value for applications, we are addressing two major challenges:

The first one concerns its encapsulation in polymer matrices while keeping its ferroelectric properties. As dabcoHBF₄ is soluble in solvents (as water), it can be blended with soluble polymers to obtain stretchable films with high dielectric or ferroelectric properties. We will present the first dielectric results of dabcoHBF₄ - PVDF polymer matrices in the context of energy harvesting systems.

The second one concerns the possibility of sub-micrometric thin film processing of dabcoHBF₄. We have particularly promising first results of a sublimation new method on insulating or conducting substrates. The first measurements, in progress, will allow evaluating the dielectric and ferroelectric performances of these novel thin films.

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