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# **Coupled dielectric spectroscopy and DSC for** ferroelectric materials

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# ABSTRACT

We present here a new planar calorimeter coupling dielectric spectroscopy and DSC measurements permitting to link dielectric and thermodynamic behaviors. It is especially suited for sintered ferroelectric pellets or electroactive polymers with transition temperatures from 10 to 140°C and could be applied to thin films with high sensitivity. To show these possibilities, a hybrid molecular ferroelectric material named dabcoHBF<sub>4</sub> is studied and new features are measured in its ferroelectric-paraelectric transition.

### Studied material

### **Developped devices**

## Calibration





### Calibration process : 1) Voltage induced by power pulses @ constant Temperature



### 2) Sensitivity S $@T_i = slope of U_i vs P$





- Dielectric + DSC measurement
- DC voltage + DSC measurement
- Controlled gas athmosphere

(M/Lm)

# Dielectric-DSC Coupled measurements

### 3) Sensitivity S vs T



4) Oven – sample Thermal conductivity Effect of clamping pressure





#### **DabcoHBF**<sub>4</sub>

Lead free ferroelectrics Aqueous synthesis High T<sub>c</sub> for organics  $Pr = 4.9 \ \mu C/cm^2$ Large dielectric constant range

Ref: 1) P.P. Shi et. al . Am. Chem. Soc. 139, 1319–1324 (2018) 2) A. Olejniczak et. al Crystal Growth & Design, 18, 11, 6488-6496 (2018) 3) N. Bréfuel et.al J. Mat. Science, 56, 18582-18591. (2021)



## Conclusion and perspectives

New DSC-dielectric correlated structures shown at low heating/cooling rate

We successfully developed a new calorimeter based on thermoelectric sensors made for planar samples (such as pellets, thick films or polymer sheets) coupled with dielectric spectroscopy or voltage applications. First, we calibrated it and present its specifications. We used that coupled DSC-dielectric spectroscopy measurement to study a hybrid molecular ferroelectric material named DabcoHBF<sub>4</sub> at low scanning speeds and showed new corelated substructures in the ferroelectric-paraelectric transition.

Now, some of the following steps planned to be made soon to develop that new tool :

Device optimizations to be made

- Lower thermal noise
- Minimize temperature ramps drifts
- Upgrade cooling power

New measurements

- On thin films and polymers
- With voltage, for electrocaloric effects
- On liquids and solutions









