

# Amonio cinko formiato, legiruoto šarminiais metais, dielektrinės savybės

## Dielectric characteristics of the ammonium zinc formate with alkali metal doping

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Recently, the scientific community has shown significant interest in  $[\text{NH}_4][\text{Zn}(\text{HCOO})_3]$  metal-organic framework. Guan-Cheng Xu et al. reported a phase transition from a paraelectric phase ( $P6_322$ ) to a ferroelectric phase ( $P6_3$ ) at a temperature of 181 K [1]. Additionally, metal organic frameworks (MOFs) hold promise for magnetism, given the flexibility to modify metal centers, making them potential candidates for single crystal multiferroic materials. Our initial investigations indicated a propensity for alkali metals to diffuse into the  $[\text{NH}_4][\text{Zn}(\text{HCOO})_3]$  structure. Consequently, this study aims to explore the impact of potassium impurities on the dielectric properties within the crystal structure of  $[\text{NH}_4][\text{Zn}(\text{HCOO})_3]$ .

Dielectric measurements were conducted within the temperature range of 130 K to 300 K and a frequency range of 10 Hz to 1 GHz, utilizing an HP 4284A LCR meter and Agilent 8714ET vector network analyzer. The crystals were carefully oriented to ensure the electrical field was aligned with the z-axis during measurements. Experiments were conducted at cooling/heating rates of 1 K/min. Figures 1 and 2 display temperature and frequency dependence of dielectric permittivity. The preliminary investigation demonstrated a subtle shift in the phase transition temperatures from 180 K to 161 K. Furthermore, the results revealed a noticeable relaxation below the phase transition temperature, likely associated with domain wall motion.

Finally, the experimental data was fitted using a superposition of several Cole-Cole functions. The obtained relaxation times were then approximated using the Arrhenius law. The calculated activation energies for the low-temperature relaxation were found to be  $EA=0.15 \pm 0.02$  eV for the pure sample and  $EA=0.34 \pm 0.02$  eV for the sample containing 5% potassium impurities. The considerable increase in activation energies could be attributed to the pinning of domain walls to point defects induced by potassium, hindering the motion of domain walls.

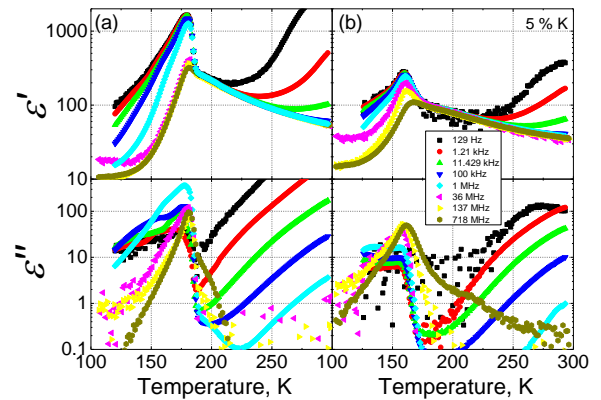


Figure 1 Temperature dependence of the real (top) and imaginary (bottom) parts of dielectric permittivity of  $[\text{NH}_4][\text{Zn}(\text{HCOO})_3]$  crystal along the c – axis. (a) pure (b) with 5 % potassium.

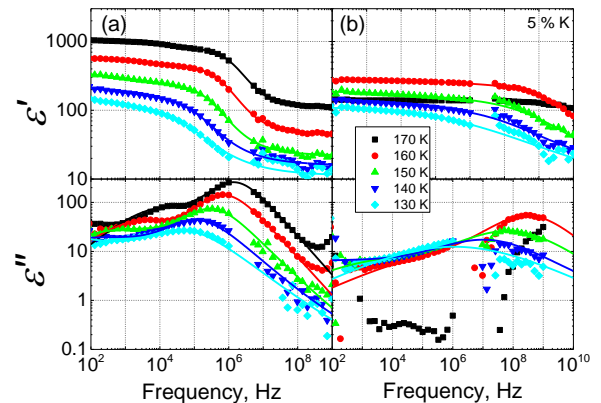


Figure 2 Frequency dependence of the real (top) and imaginary (bottom) parts of dielectric permittivity of  $[\text{NH}_4][\text{Zn}(\text{HCOO})_3]$  crystal along the c – axis. (a) pure (b) with 5 % potassium.

**Key words:** dielectric permittivity, MOFs, perovskites, phase transitions.

### Literature

[1] Xu, Guan-Cheng, et al. Journal of the American Chemical Society 133.38 (2011): 14948-14951.