Dielectric properties of layered $Cu_{0.15}Fe_{1.7}PS_3$ polycrystals

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Introduction Layered crystals of the $Me1Me2P_2S_6$ family are promising 2D functional materials for nanoelectronics. One of the most interesting of them is $CuInP_2S_6$ and solid solutions based on it. However, the family of these materials contains many crystals that can be used as catalysts, solid electrolytes, hydrogen storage devices, or active media for various types of sensors. Among them, $Cu_{0.15}Fe_{1.7}PS_3$ can be noted, which, according to our data, can be used as a humidity sensor.

Methods We investigated the temperature dependence of the dielectric constant of $Cu_{0.15}Fe_{1.7}PS_3$ crystals in the temperature interval 80÷450 K and the frequency range 10÷10^5 Hz. At low temperatures (100÷200K), the dielectric properties of samples are determined by the Maxwell-Wagner relaxation and, as indicated in [1], appear at the interfaces between crystallites and boundaries.

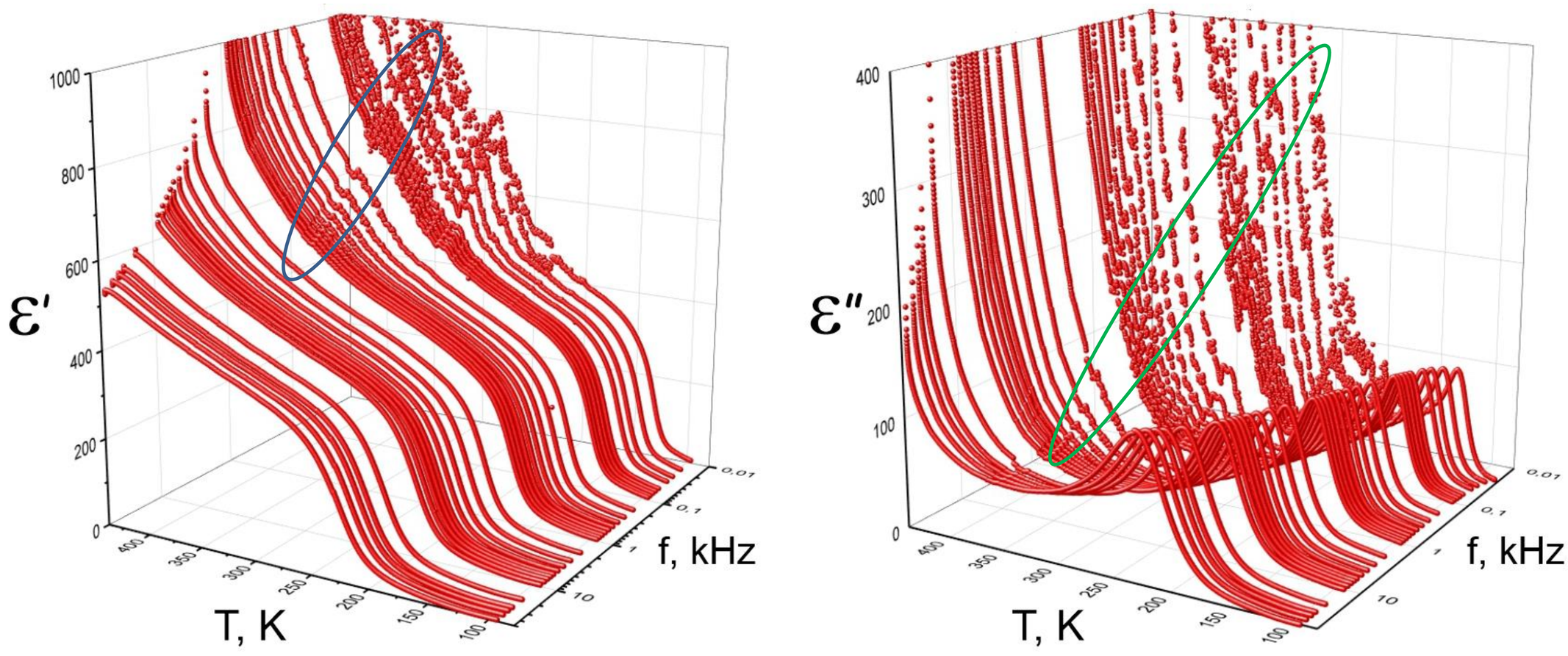

Fig. 1. Temperature dependence of real and imaginary part of dielectric permittivity of $Cu_{0.15}Fe_{1.7}PS_3$. The highlighted area indicates anomalies at 373K.

Results In addition to these features, we found two more anomalies in both the permittivity and dielectric losses at temperatures of 273K and 373K at low frequencies, which is most likely associated with the presence of water molecules in the interlayer space, as evidenced by the disappearance of this anomalies after short-term annealing of the samples at a temperature of 400K. The magnitude of the "depth" of anomalies, as it turned out, depends on the humidity of the environment. The disadvantage of this phenomenon (and maybe an advantage) can be considered its cumulative nature.

Conclusion The change in dielectric permittivity and loss anomalies at temperatures of 273K and 373K at low frequencies depends on the ambient humidity, which can be used to create nanoscale humidity sensors based on $Cu_{0.15}Fe_{1.7}PS_3$.

References

1. Dziaugys A., Macutkevic J., Svirskas S., Juskenas R., Wencka M., Banys J., Motria S.F., Vysochanskii Yu. Maxwelle-Wagner relaxation and anomalies of physical properties in $Cu_{0.15}Fe_{1.7}PS_3$ mixed material // Journal of Alloys and Compounds – 2015. – **650**, P. 386-392.