DIELECTRIC SPECTROSCOPY OF PHOSPHATE-BONDED $BaTiO_3$ -$CoFe_2O_4$ MAGNETOELECTRIC CERAMICS.

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In the era of artificial intelligence and machine learning, the growing need for compact, energy-efficient devices in consumer electronics and data storage has driven the search for innovative multifunctional materials that could replace conventional semiconductor technologies. Among the most promising candidates, multiferroic materials have attracted considerable attention over the past 15 years due to their exceptional physical properties and potential technological applications.

Multiferroics are materials that simultaneously exhibit two or more ferroic orders—namely ferroelectricity, ferromagnetism, and ferroelasticity. Their most important property is the magnetoelectric coupling effect, which enables magnetization to be controlled by an electric field and polarization to be influenced by a magnetic field. This coupling allows direct electrical control of magnetic properties and vice versa, paving the way for low-power devices such as magnetoelectric sensors, memory elements, spintronic components, microwave devices, and four-state logic systems, where magnetic storage bits (±M) are manipulated using electric fields (±E), thereby enhancing computing performance.

For the material to have appropriate multiferroic properties, both phases need to have a low tendency to react with each other. However, during sintering of such ceramics, they are subject to high temperatures upwards of 1000 °C. As a result unexpected and new phases may form due to interphasial diffusion and chemical reactions. Additionally, they have to retain their respective properties in the same temperature window. Such requirements reduce the possible combinations down to very few, like $BaTiO_3$ and $CoFe_2O_4$ or $NiFe_2O_4$. But even working with these materials researchers meet difficulties.

As a solution to these problems, an attempt was made to forgo the sintering step of production altogether by binding the ceramics with $AlPO_4$ – based glue. The samples were produced by dissolving $AlPO_4$ in water, which was then added to a mixture of $BaTiO_3$ and $CoFe_2O_4$ and homogenized in an agate mortar. The ceramics were formed by pressing the mixture uniaxially and then were left to cure. To speed up the curing process, samples were heated to a temperature of 300 °C for 1 hour, which is a way lower temperature than what is used during classic sintering process. In this work, dielectric properties of samples with differing grain sizes of $BaTiO_3$ and $CoFe_2O_4$ are investigated.

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