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Structural, dielectric and electrical properties of 'Ca' modified $BaFe_{1/2}Nb_{1/2}O_3$ complex perovskite

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Complex perovskites having $AB_xB'_{(1-x)}O_3$ general structural prototype exhibits excellent dielectric properties over a sensibly broad temperature range and are used in fabricating dielectric resonators, filters, and capacitive parts. Among them, $PbFe_{1/2}Nb_{1/2}O_3$, $PbFe_{1/2}Ta_{1/2}O_3$, $PbFe_{2/3}W_{1/3}O_3$, $PbMg_{1/3}Nb_{2/3}O_3$ are extensively studied. $BaFe_{1/2}Nb_{1/2}O_3$ (BFN) is a potential lead-free complex perovskite with intriguing dielectric properties and has been successfully synthesized through various techniques like solid-state reaction route, chemical process, molten salt method, columbite precursor method, and so on [1-3]. As per literature elements like Bi, La, Sr, Na, Ca in various amounts have been doped in BFN to further enhance its properties. In this particular work, we have doped Ca at the A-site of BFN and investigated its structural, dielectric, and electrical characteristics. For the preparation of the $Ba_{0.92}Ca_{0.08}Fe_{0.5}Nb_{0.5}O_3$ sample, we have followed the solid-state reaction route which is a simple, reliable, and low-cost technique. Some of our vital findings are listed below:

a) X-ray diffraction analysis confirms sample formation and reveals its monoclinic crystal symmetry.
b) The graphics obtained through scanning electron microscopy and energy-dispersive X-ray spectroscopy infers the dense surface morphology and purity of the synthesized sample.
c) Dielectric parameters like ε_r (figure 1) and $\tan\delta$ are studied as a function of frequency (100 Hz – 500 kHz) within temperature range 20 °C – 300 °C and the obtained spectra are found consistent with the Maxwell-Wagner model.
d) Impedance spectroscopy analysis depicts the contribution of grain and grain boundaries in the conduction mechanism. The semicircular arcs of the Nyquist plot (figure 2) signify that the sample is semiconducting following the negative temperature coefficient of resistance behavior.

A detailed explanation will be presented in the full length paper.

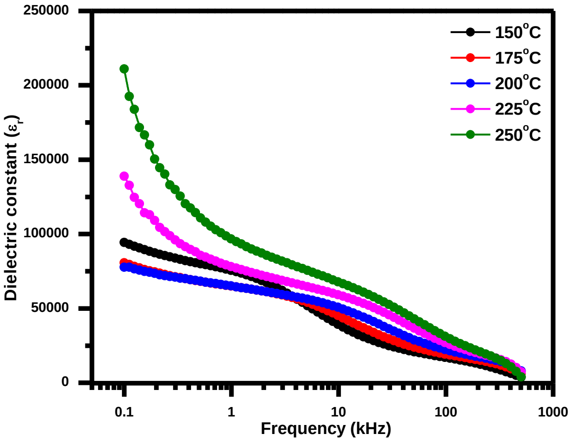

Figure 1: Variation of dielectric constant with frequency

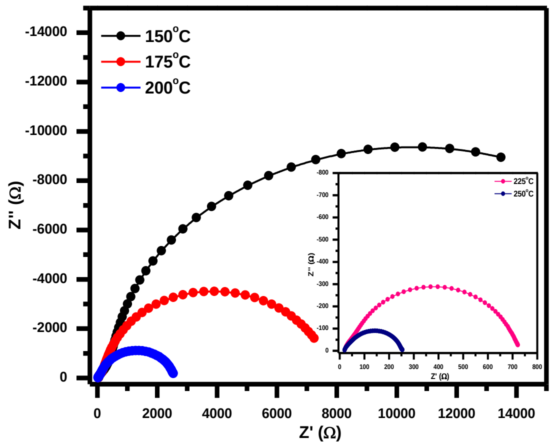

Figure 2: Nyquist plot

References

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