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Study of Electric Modulus and Scaling Behavior in $YFeO_3$

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Abstract—*$YFeO_3$ is a canted antiferromagnetic compound with Néel temperature (T_N) ~ 640 K. Very recently Shang et al [1] reported type-II multiferroicity in $YFeO_3$ at room temperature where the ferroelectricity was found to be induced by the canting of Fe^{3+} spins. The recent and renewed interest in $YFeO_3$ is due to its exhibition of magnetic-induced ferroelectricity at room temperature. However, due to its weak magneto-electric coupling, dielectric relaxation is being studied to utilize as an alternate to magneto-electric effect. We report here the structural and electric modulus study along with its scaling behavior in order to make a comprehensive understanding of dielectric relaxation in $YFeO_3$. The sample was prepared by solid state route. The X-ray diffraction patterns confirm the phase purity of the sample and its Rietveld refinement reveals the orthorhombic crystal structure with Pnma space group. The lattice parameters are found to be a = 5.5948(2) Å, b = 7.6066(3) Å and c = 5.2834(2) Å. An asymmetric peak in the plot of imaginary part of electric modulus (M") vs. frequency which could be fitted to Kohlraush-Williams-Watts (KWW) decay function demonstrates the non-Debye type dielectric relaxation. Two distinguished values of activation energy viz. 1.62 eV and 0.52 eV below and above T_N respectively depicts that the migration of oxygen vacancies in antiferromagnetic state and carrier hopping in Fe^{2+} and Fe^{3+} in paramagnetic state are responsible for dielectric relaxation. The scaling behavior of M" also suggests two types of charge carriers responsible for relaxation. The semicircular arc in complex electric modulus (M*) plot reveals the grains and grain boundaries contribution to the dielectric relaxation and could be fitted to two equivalent electrical circuit below T_N. The grain boundary contribution diminished above T_N producing a clear dielectric anomaly across the T_N.*

References

[1] M. Shang *et al*., Appl. Phys. Lett. 102 (2013) 062903.