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INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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Programme of Study : **Ph.D.**

Thesis Title: **Structural, dielectric and Raman Spectroscopic investigations of the composites of alkaline niobates ($NaNbO_3$, $KNbO_3$) and Mott-Insulators (NiO, MnO_2)**

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SHORT ABSTRACT

Crystal structural, dielectric and Raman spectroscopy of various compositions (x) of two-phase composites comprising alkaline niobates ($NaNbO_3$, $KNbO_3$) and Mott-insulators (NiO, MnO_2) are investigated. Incorporation of antiferromagnetic NiO in antiferroelectric $NaNbO_3$ causes significant lattice distortion from Orthorhombic to Monoclinic symmetry at room-temperature. The XPS analysis reveals pentavalent and monovalent 'Nb' and 'Na', respectively. Temperature dependence of dielectric spectroscopy reveals anomaly across 170°C which is rarely reported in literature related with the incommensurate phase transition of $NaNbO_3$. This anomaly is visible in dilute ($x \leq 0.05$) as well as higher x (≥ 0.95) of NiO. Very high relative-dielectric permittivity (ε_r) with low-losses were observed in all the investigated composites. The analysis of ac-resistivity (ρ) versus temperature data provides the evidence for the Variable Range Hopping (VRH) mechanism of charge carriers in the system. Large thermal hysteresis in $\varepsilon_r(T)$ and $\rho(T)$ was noticed across 200°C signifying the first-order nature of the crystallographic phase transition $T_{P\text{-}R}$. Low-temperature vibrational spectra provides the evidence of new Raman-active modes along with the Two-Magnon modes of NiO. Structural characterization of MnO_2-$NaNbO_3$ composites reveals the emergence of two different secondary phases, namely Mn_3O_4 and Mn_2O_3 after sintering at 1000°C and 1040°C, respectively. These phases are having significant effect on the overall vibrational spectra of the composites. With decreasing temperature, all the modes get sharper and majority of the peaks shift towards higher wavenumber side. Positional hysteresis and positive temperature coefficient are the striking features observed in the Raman spectroscopy of MnO_2-$NaNbO_3$ composites. On the other hand, the high-temperature dielectric spectroscopic study of $KNbO_3$-NiO two-phase composites reveal the frequency dispersion in $\varepsilon_r(T)$ which characterizes weak Relaxor-like behaviour. Such Relaxor behaviour was confirmed by the scaling law studies pertaining to: Vogel-Fulcher analysis and Uchino-Nomura criterion. Moreover, the VRH analysis shows deviation from the hopping mechanism for higher compositions of the $KNbO_3$-NiO composites. The Raman spectra of these composites reveal the presence of Two-Magnon modes at room-temperature for high compositions of NiO (x = 0.95), whereas for compositions (< 0.20), the Phonon and Magnon modes of NiO are absent due to the higher intensity of Raman-active modes of $NaNbO_3$.