Structural, Electrical and Magnetic Properties Inspection for Rare-earth Substituted Magnetic Dense Ceramics Synthesize from Nanoferrites

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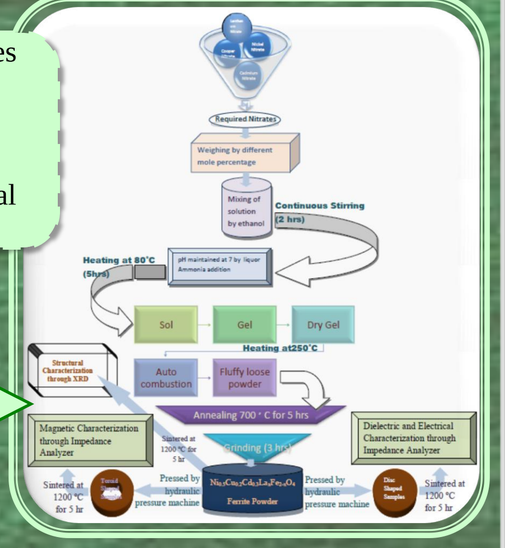
INTRODUCTION

- Nanotechnology is covering the present trend of technological demand of developing miniaturization and cost-effective new materials with high performance devices with its exotic properties along with small size.
- However, nano-powder specimens are not applicable in many electronic applications due to its lower density where dense ceramics are the only solution.
- For that purpose, $Ni_{0.5}Cu_{0.2}Cd_{0.3}La_xFe_{2-x}O_4$ bulk ceramics were prepared by sol-gel and sintered at 1200 ºC.
- The prepared samples were inspected through different analyses so that structural, electrical and magnetic properties of these samples could show the way of potential candidate in technological devices.

METHODS

- La substituted NiCuCd nano-ferrite powders were prepared by sol-gel process.
- Using the synthesized nano-powders dense ceramics were prepared and sintered at 1200 °C.
- The resulting specimens were characterized through X-ray Diffractometer (XRD), Vibrating Sample Magnetometer (VSM) and Impedance Analyzer.
- Then analyzed theoretically by different theoretical fitting process.



RESULTS

Structural Analysis

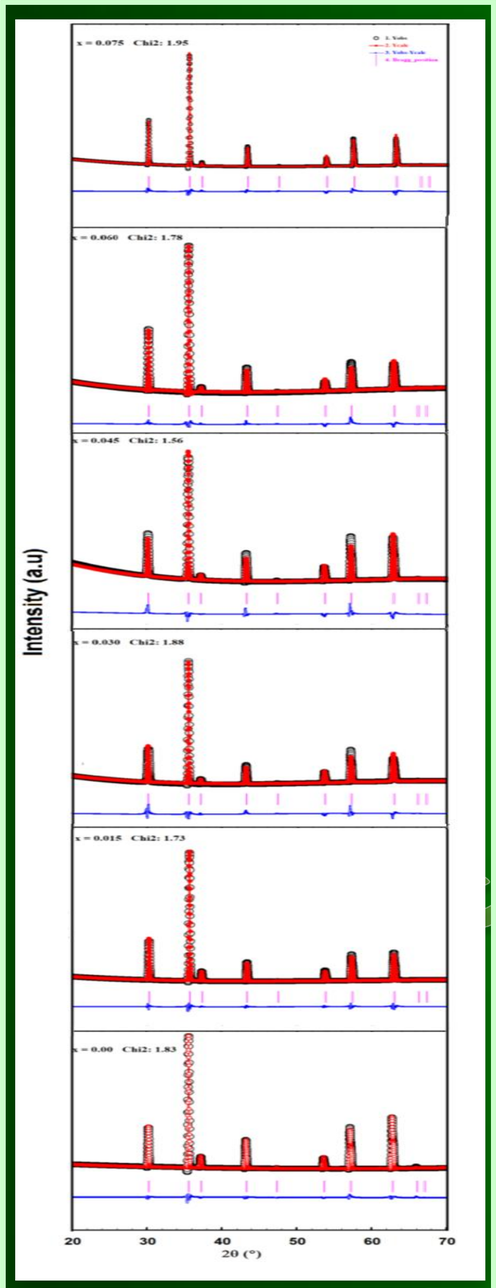


Fig. 2: Rietveld refined patterns

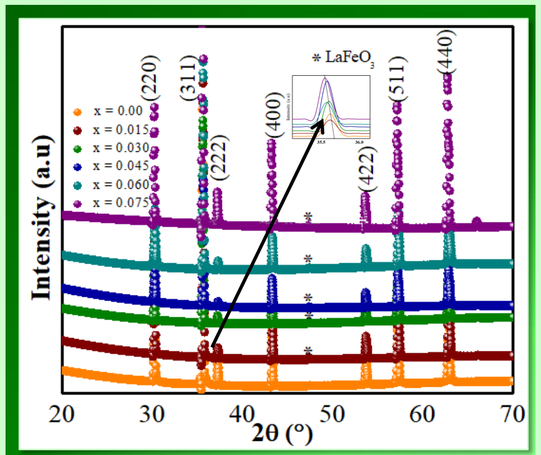


Fig. 1: XRD spectra

Fig. 4: MEM map

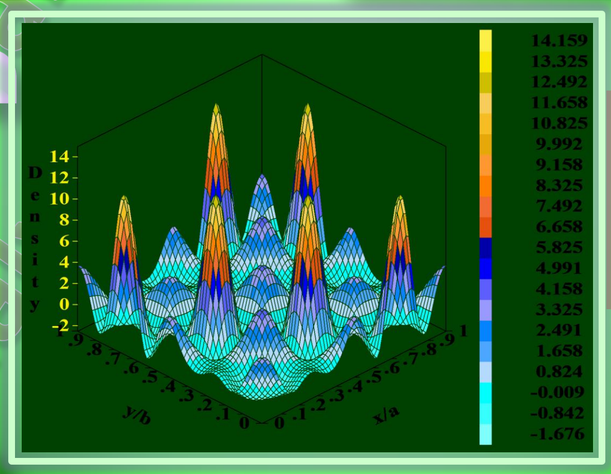


Fig. 3: Crystal Structures

Electrical Analysis

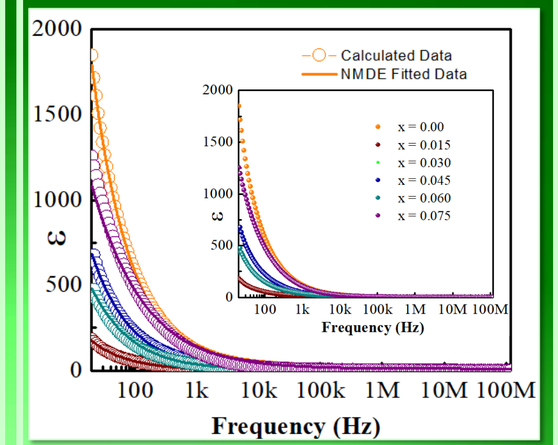


Fig. 5: Non-modified Debye Equation (NMDE) fitted dielectric constant (ε) curves

Magnetic Analysis

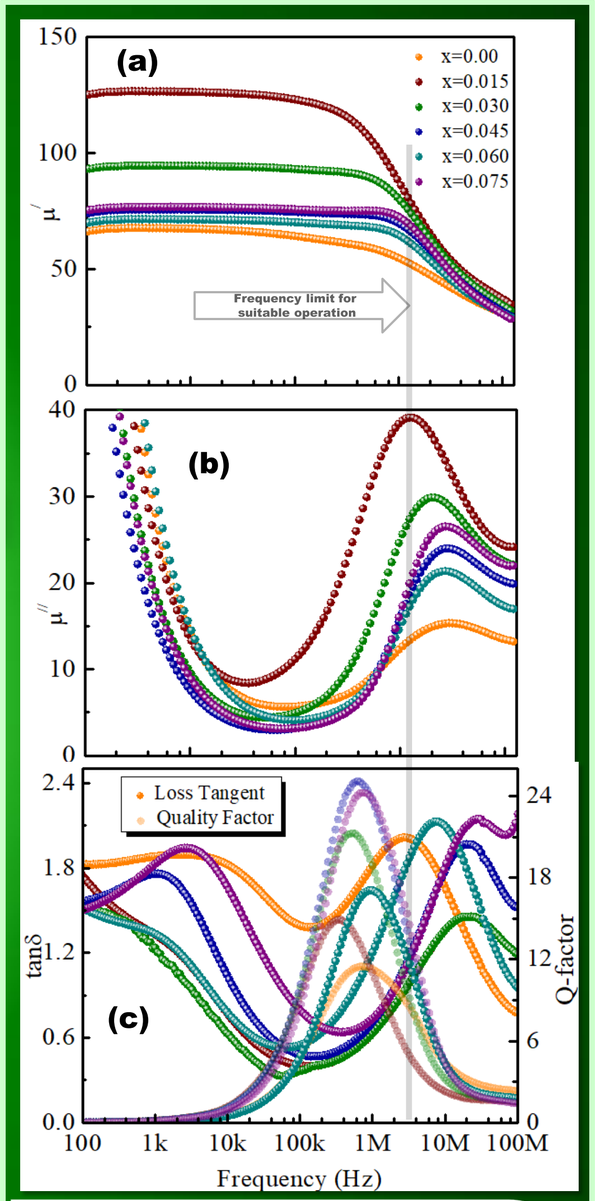


Fig. 6: a) Real part of initial permeability (μ') b) imaginary part of initial permeability (μ'') and c) combined graph of dielectric loss tangent and quality factor

CONCLUSION

- Dense ceramics have been prepared successfully from nanocrystalline ferrite powders at 1200 °C sintering temperature and Rietveld refinement has found good fitting values (χ^2 = 1-2).
- La shows preference towards B-sites more than A-sites and MEM map reveals the electron density distribution along with covalent bond as the greater bond type.
- Dielectric loss tangent has been reduced remarkably by the La substitution and Q-factor rises between the specific frequency range where the drop of tanδ is maximum.
- This investigation found that the synthesized bulk ceramics at 1200 °C sintering temperature is applicable in multifunctional devices.