Magnetic and electrical behaviours of NiCuCdLa dense ceramics with Rietveld refinement

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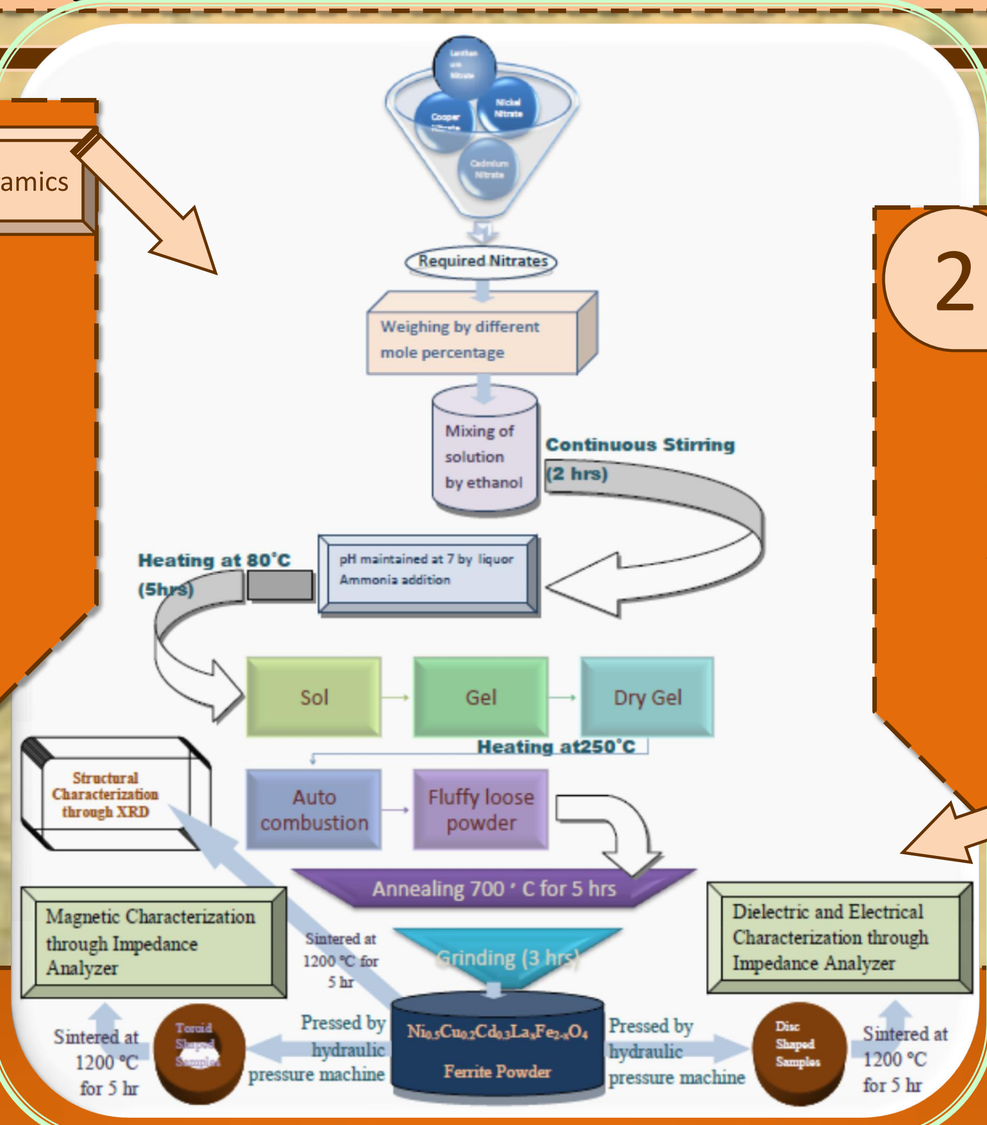
INTRODUCTION

- 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

1 Synthesis and Preparation of Dense Ceramics

- Required metallic salts were dissolved in CH_3COOH.
- pH of solution kept at 7 using liquor NH_4OH.
- La substituted NiCuCd nano-ferrite powders were prepared by sol-gel process.
- Disc and ring shaped specimen were fabricated.
- Using the synthesized nano-powders dense ceramics were prepared and sintered at 1200 °C.



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- The resulting specimens were characterized through X-ray Diffractometer (XRD) for structural information.
- Vibrating Sample Magnetometer (VSM) was used for magnetic information.
- Impedance Analyzer was used for electric and dielectric information.
- Then analyzed theoretically by different theoretical fitting process.

Characterizations for Different Spectroscopy Analysis

RESULTS

Structural Analysis

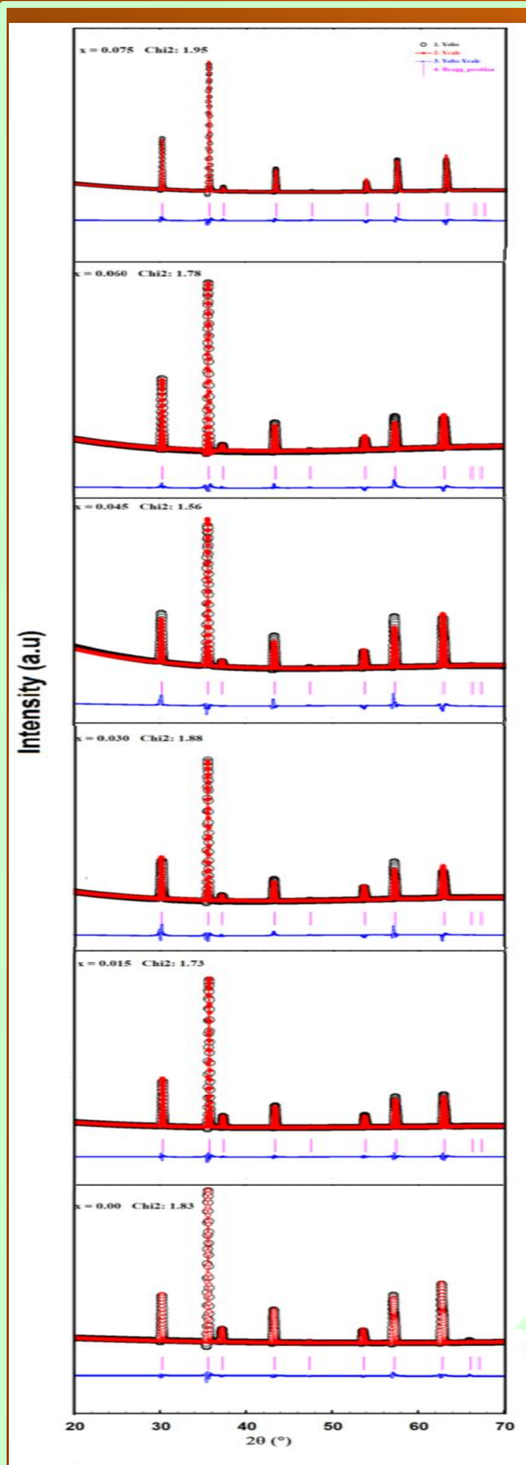

Fig. 2: Rietveld refined patterns

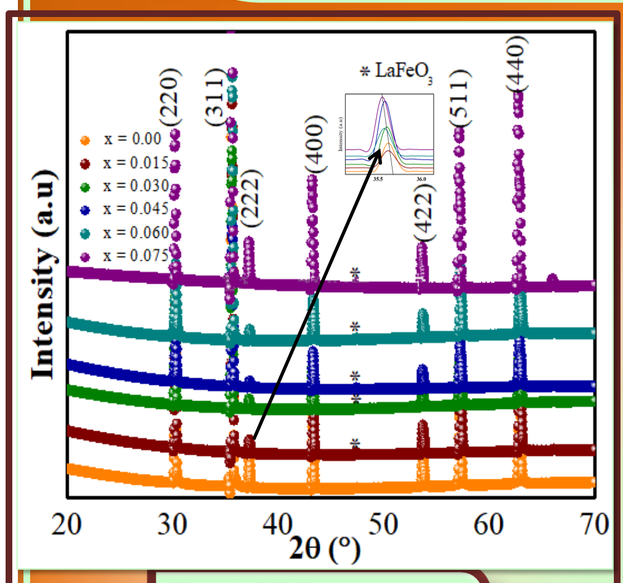

Fig. 1: XRD spectra

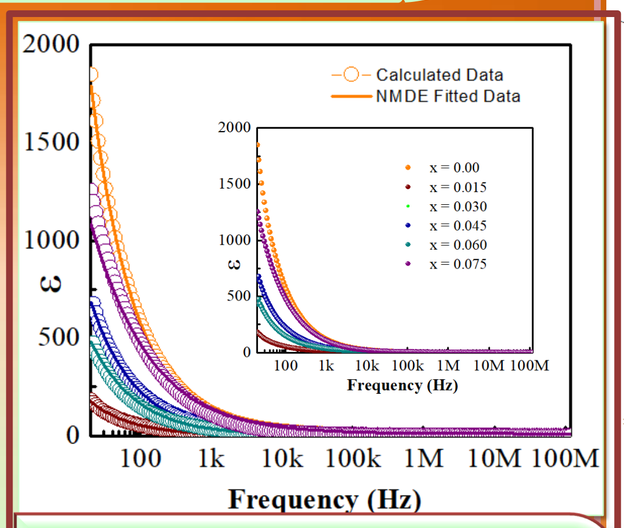

Fig. 5: Non-modified Debye Equation (NMDE) fitted dielectric constant (ε) curves

Fig. 4: MEM map

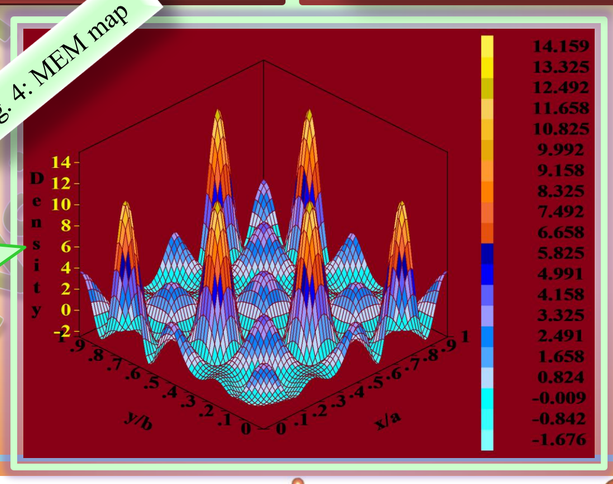

Fig. 3: Crystal Structures

Electrical Analysis

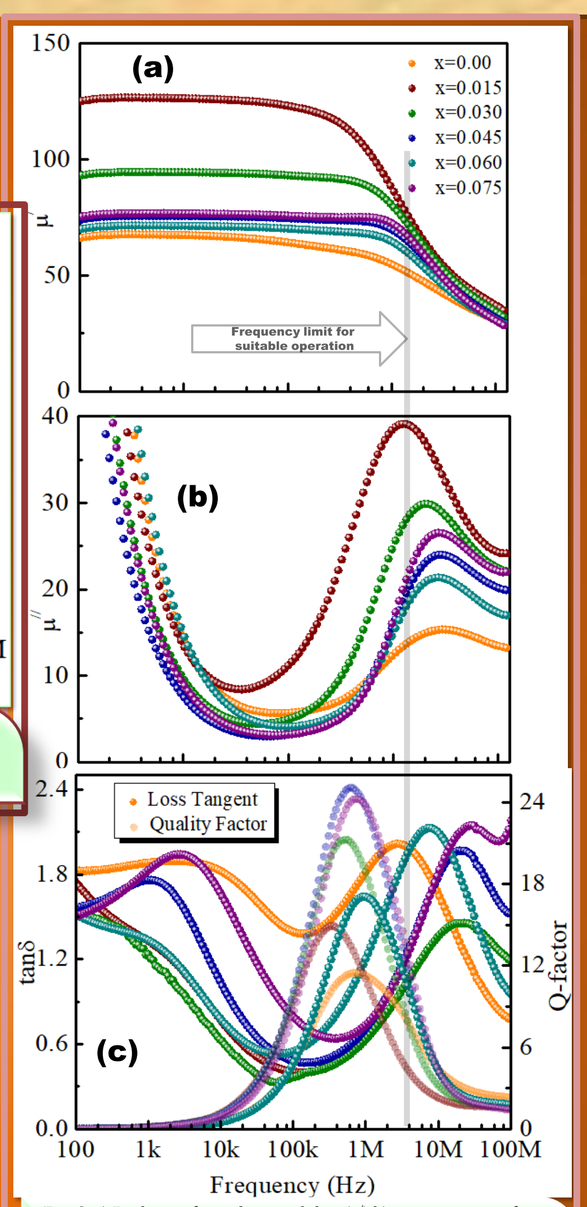

Fig. 6: a) Real part of initial permeability (μ′) b) imaginary part of initial permeability (μ″) and c) combined graph of dielectric loss tangent and quality factor

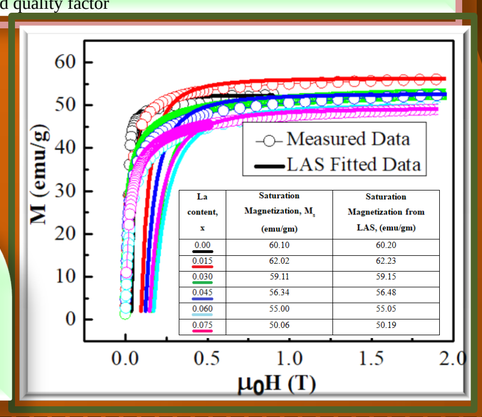

Fig. 7: Magnetization curves with Law of Approach to Saturation

Magnetic Analysis

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.