COMPARATIVE STUDY OF $Ni_{0.8}Co_{0.1}Cu_{0.05}Mn_{0.05}Fe_2O_4$ PREPARED BY DRY COMBUSTION AND SOLUTION COMBUSTION METHODS

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Abstract:-

The comparative study of electrical and dielectric properties of $Ni_{0.8}Co_{0.1}Cu_{0.05}Mn_{0.05}Fe_2O_4$ prepared by dry combustion and solution combustion is reported in this paper. The $Ni_{0.8}Co_{0.1}Cu_{0.05}Mn_{0.05}Fe_2O_4$ was synthesized by dry combustion as well as solution combustion methods. The X - ray diffraction pattern reveals the cubic spinel phase formation with extra Fe_2O_3 phase for $Ni_{0.8}Co_{0.1}Cu_{0.05}Mn_{0.05}Fe_2O_4$ prepared by dry combustion method. The SEM micrographs were taken to study the morphology of the samples. The SEM images show agglomerated grains with comparatively large grain size for $Ni_{0.8}Co_{0.1}Cu_{0.05}Mn_{0.05}Fe_2O_4$ prepared by dry combustion. The D.C. electrical resistivity was done by two probe method with temperature range from room temperature to 600^0C.The dielectric constant with variation in frequency shows the dispersion behavior.

Keywords:- Ferrite, Resistivity, combustion.

INTRODUCTION

Ferrites are the ferrimagnetic materials with high technical interest due to its interesting electrical and magnetic properties. Nickel ferrite exhibits the inverse spinel structure and has high electrical resistivity among the ferrite family These ferrites are used in radio frequency circuits, high quality filters, rod antennas, transformer cores, read/write heads for high-speed digital tapes, and operating devices.[1]. Ferrite nanoparticles display features like high field magnetization irreversibility, variation in Neel temperature, higher values of coercivity, lower values of saturation magnetization and saturation magnetization is altered (reduced or enhanced) when synthesized by using combustion route.[2].

Experimental

$Ni_{0.8}Co_{0.1}Cu_{0.05}Mn_{0.05}Fe_2O_4$ was prepared by dry combustion as well as solution combustion. In dry combustion AR grade nickel nitrate, cobalt nitrate, cupric nitrate ,manganese nitrate ferric nitrate and glycine were taken into proper molar proportion which forms the precursors and after giving the heat treatment converted into slurry. After reaching the ignition temperature of glycine it combusts along whole volume to form $Ni_{0.8}Co_{0.1}Cu_{0.05}Mn_{0.05}Fe_2O_4$. In solution combustion method the starting materials taken in proper molar proportion and dissolved in double distilled water using magnetic stirrer and pH of solution was adjusted to 6. After constant stirring and heating about 80^0 C gel was formed. The temperature of the gel reaches to the ignition temperature of glycine it undergoes self combustion giving out voluminous black ash as a final product. Both the samples were sintered at 700^0C and pelletized for further characterization. X-ray diffraction analysis in the range from 20° to 100° with the standard scanning rate of 2°/min was performed using a Philips PW 3710. SEM images were taken from JEOL-JEM-6360 scanning electron microscope. The electrical DC resistivity measurement was carried out using usual two-probe method in the temperature range from room temperature to 600 $^\circ$C.

Results and Discussion

Fig.1. shows XRD patterns of $Ni_{0.8}Co_{0.1}Cu_{0.05}Mn_{0.05}Fe_2O_4$ prepared by dry combustion and solution combustion. The sample prepared by dry combustion shows formation of spinel ferrite with extra Fe_2O_3 phase it may be due to fraction of ferric nitrate was converted into Fe_2O_3.The sample prepared by solution combustion confirms formation of spinel ferrite without any impurity due to homogeneous mixture of starting precursors. Fig.2. show SEM images of $Ni_{0.8}Co_{0.1}Cu_{0.05}Mn_{0.05}Fe_2O_4$ prepared by dry combustion and solution combustion. It is observed that loosly agglomerated grain structure due to high local temperature (about 1000^0c) during combustion and grain size of ferrite prepared by dry combustion is large (0.35μm) than that of ferrite prepared by solution combustion(0.14μm).

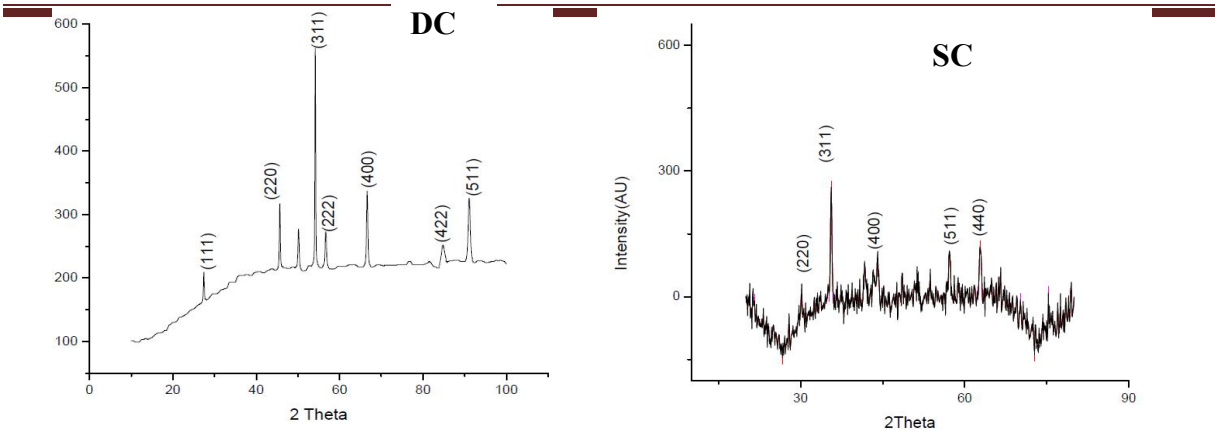

FIGURE 1. XRD patterns of $Ni_{0.8}Co_{0.1}Cu_{0.05}Mn_{0.05}Fe_2O_4$ prepared by dry combustion (DC) taken with Cr target and solution combustion (SC) taken with Cu target.

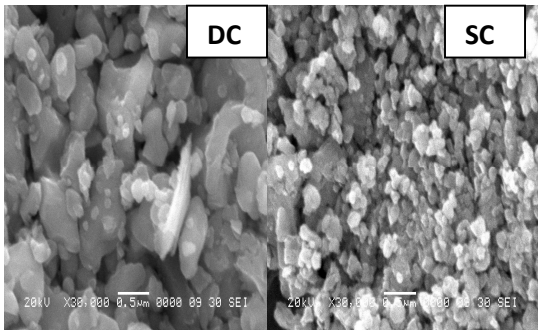

FIGURE 2 SEM images of $Ni_{0.8}Co_{0.1}Cu_{0.05}Mn_{0.05}Fe_2O_4$ prepared by dry combustion (DC) and solution combustion (SC)

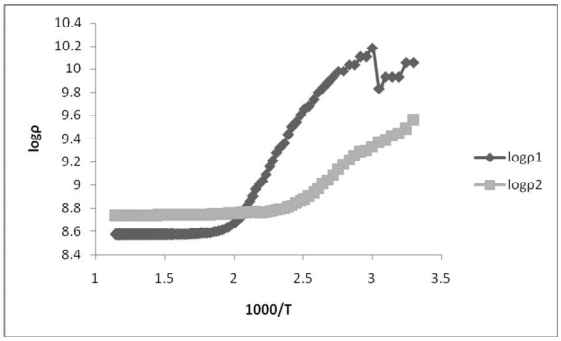

FIGURE 3 Resistivity of $Ni_{0.8}Co_{0.1}Cu_{0.05}Mn_{0.05}Fe_2O_4$ prepared by dry combustion and solution combustion .

Fig.3. shows D.C. electrical resistivity of $Ni_{0.8}Co_{0.1}Cu_{0.05}Mn_{0.05}Fe_2O_4$ prepared by dry combustion and solution combustion.It is seen from fig. the ferrite samples shows semiconducting behavior as resistivity decreases with increase in temperature and resistivity of ferrite prepared by dry combustion gives large resistivity than ferrite prepared by solution combustion. Here Fe_2O_3 phase may contribute for observing the high value of resistivity.

Fig.4 shows variation of dielectric constant of $Ni_{0.8}Co_{0.1}Cu_{0.05}Mn_{0.05}Fe_2O_4$ prepared by dry combustion and solution combustion. It is observed that dielectric constant decreases with increase in frequency which shows usual dispersion behavior of the Ni Co Cu Mn ferrite system and has large value for the sample prepared by solution

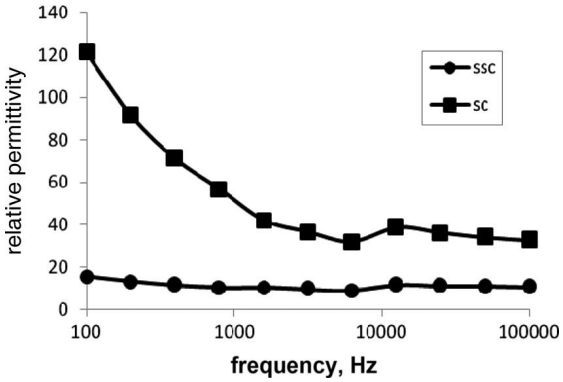

FIGURE 4 Variation of dielectric constant with frequency for samples prepared through dry combustion (ssc) and solution combustion (sc) .

Conclusions:-

Pure phased sample obtained by solution combustion. Average grain size of ferrite prepared by dry combustion is large (0.35μ) than ferrite prepared by solution combustion (0.14μ). Resistivity of both the samples is observed to be3 to 4 times larger(10^9-10^{10}Ω-cm) than reported.The ferrite sample prepared by solution combustion method gives high dielectric constant than sample prepared by dry combustion.

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References:-

1. Qian Chen, Piyi Du,a Wenyan Huang, Lu Jin, Wenjian Weng, and Gaorong Han Appl. Phy. Lett. **90**, 132907 (2007)
2. John Jacob1 and M. Abdul Khadar Jour. Appl. Phy 107, 114310 (2010)
3. Z. P. Niu Y. Wang F. S. Li J Mater Sci41, 5726 (2006)