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# Golden Research Thoughts

**GRT**

## SYNTHESIS AND CHARACTERIZATION OF COPPER NICKEL ZINC FERRITE USING SOL GEL METHOD BY AUTO-COMBUSTION ROUTE



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### ABSTRACT

A zinc substituted copper nano ferrites with the compositional formula  $\text{Cu}_{0.3}\text{Ni}_{0.3}\text{Zn}_{0.3}\text{Fe}_2\text{O}_4$  & without zinc substituted  $\text{Cu}_{0.5}\text{Ni}_{0.5}\text{Fe}_2\text{O}_4$  were prepared by the Citrate gel auto combustion technique and sintered at  $700^\circ\text{C}$  for 4 hr. The X-ray diffractograms (XRD) clearly exhibited the existence of single phase cubic spinal structure. The crystallite size was found in the range of 10-55nm.

**KEYWORDS** :zinc substituted copper , Materials and Methods , crystallite size .

### MATERIALS AND METHODS

#### SYNTHESIS OF FERRITE POWDER :

Ferrite powders were prepared by sol-gel auto combustion method. Analytical grade Nickel Nitrate  $[\text{Ni}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}]$ , Zinc Nitrate  $[\text{Zn}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}]$ , Copper Nitrate  $[\text{Cu}(\text{NO}_3)_2 \cdot 3\text{H}_2\text{O}]$ , Iron Nitrate  $[\text{Fe}(\text{NO}_3)_3 \cdot 9\text{H}_2\text{O}]$ , Citric Acid  $[\text{C}_6\text{H}_8\text{O}_7 \cdot \text{H}_2\text{O}]$  were used as raw materials in Sol-Gel auto combustion method. All the chemicals were from E-mark, India (GR grade with 99.9% purity).



Compound	Atomic no.	Mass no.	B.P in $^\circ\text{C}$	M.P in $^\circ\text{C}$	Structure	Oxidation state
Cu	29	63.546	2562	1084.62	FCC	+1,+2 ,+3, +4
Ni	28	58.693	2913	1455.00	FCC	+4,+3, +2, +1
Zn	30	65.380	907	419.53	hexagonal	+2,+1,0
Fe	26	55.845	2862	1538.00	BCC	+3,+2

Table (2) Basic information of materials.

**RESULT AND DISCUSSION:****1. X-Ray Diffraction Analysis**

The structural characterization of the ferrite powders as prepared was carried out using XRD system. Fig.11 shows the X-ray diffractographs of Copper nickel zinc ferrite samples. The XRD pattern clearly indicates that the prepared samples contain cubic spinel structure. The sizes of crystallites in the samples were evaluated by measuring the average FWHM of all peaks.

**Phase Analysis**

The phase formation behavior was studied by XRD. Fig. shows the XRD patterns of the as-burnt ferrite powders. The powders were in crystalline state and identification revealed spinel ferrite phases. There was no metal oxide phase in the as burnt powder. The crystallite size was calculated from average of full width at half maximum of all peaks using Scherer formula. The crystallite size of as-burnt powders can be in the range 10 to 55 nm. The as burnt powders were calcined at 700°C for 4 hrs to get more crystalline homogeneous spinel phase. The crystallite size of calcined powders was in the range 40 to 80 nm. The crystallite size increased with increasing concentration of copper and nickel in absence of zinc.

Sr. no.	Sample name	Average D
1	$\text{Cu}_{0.3}\text{Ni}_{0.3}\text{Zn}_{0.3}\text{Fe}_2\text{O}_4$	26.4904
2	$\text{Cu}_{0.5}\text{Ni}_{0.5}\text{Fe}_2\text{O}_4$	61.8247

**Table.4 X-RD Analysis****2) MAGNETIC PROPERTIES:-**

The Hysteresis curve Show that magnetic properties of the material. The hysteresis studies the different parameter such as Saturation magnetization ( $M_s$ ), Coercive force ( $H_c$ ), and Residual magnetization ( $M_r$ ). The low coercivity the magnetic material is soft ferrite. The below fig.12 Shows that the composition of Zn increases the enhance the soft magnetic behavior, exhibiting decrease of coercivity. The powder  $\text{Cu}_{0.5-x}\text{Zn}_x\text{Ni}_{0.5-x}\text{Fe}_2\text{O}_4$  ( $x=0.0, 0.1, 0.2, 0.3, 0.4$  and  $0.5$ ) is Soft Ferrite powder because the hysteresis loop is narrow i.e area of the hysteresis loop is very small.

Samples for 'x'	Coercivity $H_c$ (Oe)	Saturation Magnetization $M_s$ (emu/gr)	Residual Magnetization 'Mr' (emu/gr)	Susc. ' $\chi$ '
0.0	4995.29950	51.1230	10.2609	0.01023
0.1	5148.6667	67.8911	11.3281	0.01318

**Table.(5) Change in different properties for  $\text{Cu}_{0.3}\text{Ni}_{0.3}\text{Zn}_{0.3}\text{Fe}_2\text{O}_4$  &  $\text{Cu}_{0.5}\text{Ni}_{0.5}\text{Fe}_2\text{O}_4$**

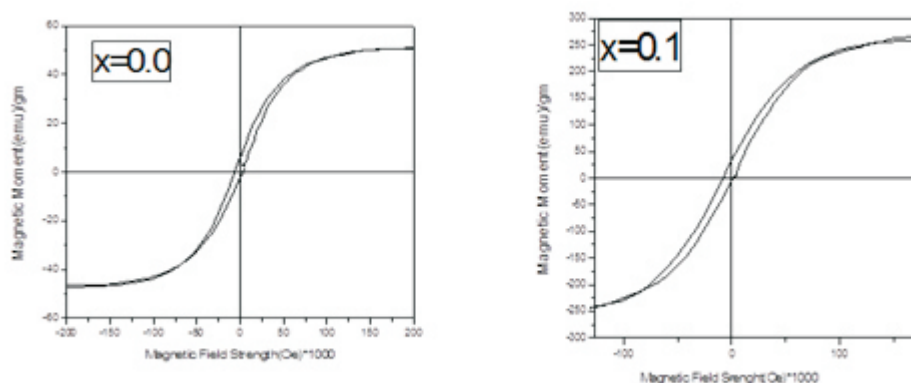
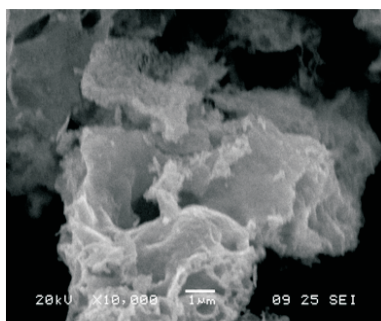


Fig. (13) Hysteresis loop of  $\text{Cu}_{0.3}\text{Ni}_{0.3}\text{zn}_{0.3}\text{Fe}_2\text{O}_4$  &  $\text{Cu}_{0.5}\text{Ni}_{0.5}\text{Fe}_2\text{O}_4$

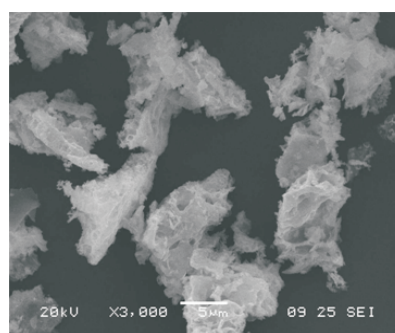
From the the variation of the coercivity ( $H_c$ ) vs change in concentration of the zinc as shown in fig. (13), it is seen that for the composition without zinc (i.e  $x = 0.0$ ) the coercivity is the highest and it goes on decreasing with increasing concentration of zinc.

### 3) SEM Analysis:

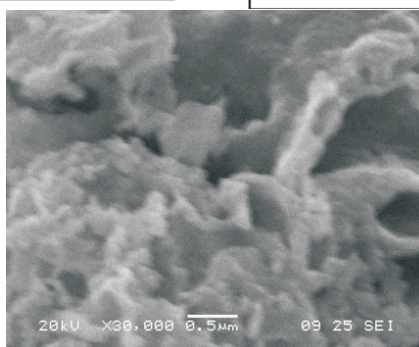
Scanning electron microscope is an instrument that is used to observe the morphology of the solid sample at higher magnification, higher resolution and depth of focus as compared to an optical microscope. In Fig. shows the SEM photographs for different concentration of  $\text{Cu}_{0.3}\text{Ni}_{0.3}\text{zn}_{0.3}\text{Fe}_2\text{O}_4$  sample with different magnification.



Magnification=10000



Magnification=3000



Magnification=30000

- SEM images shows that powder is formed with uniform size.
- We can observe the formation of soft agglomerates with irregular morphology.

• **CONCLUSIONS:**

1. The single phase Copper nickel zinc ferrite powder synthesized successfully using auto-combustion method.
2. The powder showed soft magnetic characteristics. Variation of Magnetisation saturation and Hc with increasing values of dopant concentration. Also the hysteresis curve shows soft magnetic property of ferrite.

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