Effect of Copper Doping on $CoAl_2O_4$ Ceramic Nano Pigment

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Abstract- **The effect of copper doping on the cobalt pigment was investigated. Nano-particles of $Cu_{(0.374)}$ $Co_{(0.626)}$ Al_2O_4 were prepared. Cobalt blue ceramic pigments were prepared using chemical co-precipitation method. Synthesized blue ceramic pigments are confirmed using XRD and TEM image. The cobalt blue pigment and Cu doped cobalt blue pigment both have cubic unite cell (a=b=c= 8.104 and α, β, γ=90) and doping of Cu on the Co blue pigment and mixing process did not vary the unite cell and spinel phase of the cobalt pigment. The XRD results at 200, 500, 900 and 1200 ºC showed the spinel phase of Co was perform at 500 ºC (2θ= 36.6, and d= 2.444. Increasing of temperature from 200 to 1200 ºC causes the crystallity of prepared sample of cobalt blue ceramic pigment. TEM image showed the nanosize of Cobalt blue ceramic pigment about 7nm.**

Key words: blue pigment; Ceramic pigment; $CoAl_2O_4$; Cu doping

1. Introduction

Most of the ceramic pigment materials possess the spinel structure. The main aspect of spinels is the presence of two metallic cations, A^{2+} and B^{3+}, in tetrahedral and octahedral positions, respectively [2]. Composite oxides with spinel structures (AB_2O_4) are important inorganic metalloid materials and are widely used in different fields [6]. They can be distinguished as tow basic types, normal and inverse spinels. From the formula AB_2O_4, A and B refer to two different sites in the crystalline structure.

The A-site is tetrahedral and the B-site is octahedral coordinated by oxygen. In an inverse spinel, the formula becomes tetrahedrally coordinated by oxygen, and the M, M in side bracket is octahedrally coordinated by oxygen. It was found that such kinds of ferrites are characterized by a spinel structure with high thermodynamic stability, electrical conductivity and high catalytic activity [1, 4, 5]. Recently, some chemical routes have been used to prepare this pigment hydrothermal, sol-gel, precipitation method. In this work, the naoparticles of $CoAl_2O_4$ spinel pigment prepared by chemical co-precipitation method and the Cu doping on the Co spinel was investigated.

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2. Experimental

The $CoAl_2O_4$ and doped $CoAl_2O_4$ with Cu is synthesized using co-precipitation method. The required amount of metal nitrate dissolved in deionized water. A require amount of ammonia is added into the solution in order to adjust the pH value to about 9 and then precipitate is formed. The samples heated and dry in the oven of 100 ºC for 3 h. The crystalline structure of doped $CoAl_2O_4$ was determined using the X-ray powder diffraction method with a Philips PW1840 diffractometer using Ni-filtered Cu k_α radiation and wavelength 1.54˚A.Infrared
$CoAl_2O_4$ and Cu doped $CoAl_2O_4$ were prepared using a co-precipitation method. The required amount of Co, Al and Cu nitrate were mixed and under vigorous magnetic-stirring, slowly raised the pH by adding NH_3 (5mol/L) solution to around 10 and stirring was continued for 30 min, and the stopped stirring. The suspension was heated to 95-100 ºC for 2h. After cooling, the magnetic composite was repeatedly washed with distilled water. The prepared ceramic pigments dried at 105 ºC and then calcinated at different temperature.

3. Result and discussion

3.1. XRD study

XRD patterns of synthesized materials are shown in Fig.1 the existence of a peak around the diffraction angle (20) equal to 36.5º corresponding to d 2.444 confirms the formation of spinel ferrites of $CoAl_2O_4$ and Cu doped blue pigment [3]. The values of lattice constant are determined for these materials. The cobalt blue pigment and Cu doped cobalt blue pigment both have cubic unite cell (a=b=c= 8.104 and α, β, γ=90) ad FCC system and doping of Cu on the Co blue pigment do not change the unite cell and spinel phase of the pigment.

ISBN: 978-988-18210-0-3
ISSN: 2078-0958 (Print); ISSN: 2078-0966 (Online)

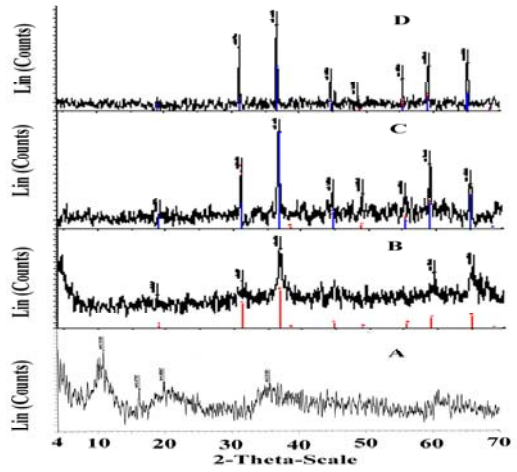

Fig. 1. Powder XRD for the $Cu_{(0.374)}Co_{(0.626)}$ Al_2O_4 calcinated at 200, 500, 900 and 1200 ºC

3.2. TEM

The morphologies of the ferrites were studied by TEM. The micrographs obtained for these materials presents a detail of the composite showing the two materials with complete different textures. The TEM image of $Mn_{0.5}Cu_{0.5}Fe_2O_4$ demonstrates that the sample particle size is small and about 7 nm. The sample is a uniform distribution of spherical particles with no obvious aggregation.

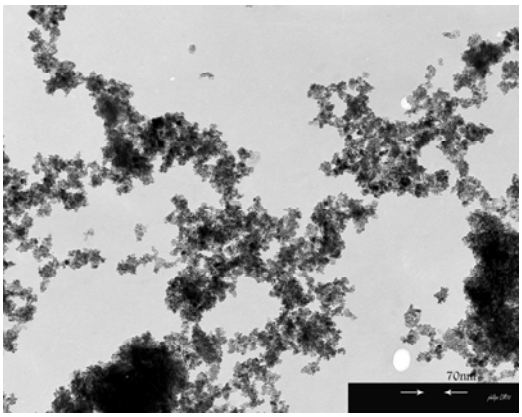

Fig. 2. TEM image of $Cu_{(0.374)}Co_{(0.626)}$ Al_2O_4 nano pigment

4. Conclusion

The effect of copper doping on the structural of Co blue ceramic pigment was investigated. The composite prepared with copper co-precipitation method. The doping of Cu did not change the lattice of $CoAl_2O_4$ from cubic. From 500 ^{0}C the spinel phase was observed.

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