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Influence of Calcination Parameters over the Morphology and Formation of Co_3O_4 Nanoparticles

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1. Introduction

Metal oxides are the most important functional materials due to their unique and tunable physical properties have made themselves excellent candidates for electronic and optoelectronic applications. Nanostructured metal oxides have been actively studied due to both scientific interests and potential applications. Co_3O_4 is an important antiferromagnetic p-type semiconductor with excellent properties such as gas-sensing, catalytic and electrochemical properties, and has been studied widely for applications in solid-state sensors, electrochromic devices and heterogeneous catalysts as well as lithium batteries [1,2]. In this study, we report the influence of calcination parameters over the formation of Co3O4 nanoparticles.

2. Methodology

Cobalt tetraoxide (Co_3O_4,) powders were prepared by the modify Pichini method which consists in a combined process of cobalt complex formation using citric acid (CA) to form stable cobalt complex and in situ polyesterification with poly(ethylene glycol) (PEG) to form the polymeric resin.

In order to obtain cobalt tetraoxide particles with different sizes and morphologies we used calcination at moderate temperatures from 300 to 1100°C. The calcination of the polymeric resin at a moderate temperature was selected to generate a pure phase multicomponent cobalt oxide. SEM and EDS characterization where performed to study the changes in morphology as well as it composition. MicroRaman Spectroscopy was used to validate our results. The most representative samples are presented in this study.

3. Results

Five of the most representative samples are presented in the following section. Figure 1shows the synthesized oxides which were calcinated at 1100°C, 900°C, 600 °C and 300°C respectively. It can be observed that the cobalt oxide consists in a microagglomerated particles, the average diameter ranging from 25 to 5 mm. From EDS we find the sample calcinated at 600 °C with a 73.4 wt % Co and 26.6 wt % O, to validate the EDS results RAMAN study was conducted. In a typical Raman spectrum of cobalt oxide nanoparticles. It can be distinguished five active Raman modes located approximately at ~185.5, ~465.3, ~506.6, ~601, ~670, and ~755.5 [3]. This results are in agreement whit the values of at and ~200.007, ~482.124, ~522.45, ~619.86 and ~688.78 cm^{-1} .

4. Conclusion

We can observe the influence of different calcination temperatures, for the highest (1100 °C) the resulting particles are sintered , in the other hand for the lowest temperature (300°C) the particles were agglomerated, and for both cases wt% does not agree with Co_3O_4. In the medium point at 600°C we find a well defined morphology and in agreement with Co_3O_4 this can be corroborated by the EDS and RAMAN results.

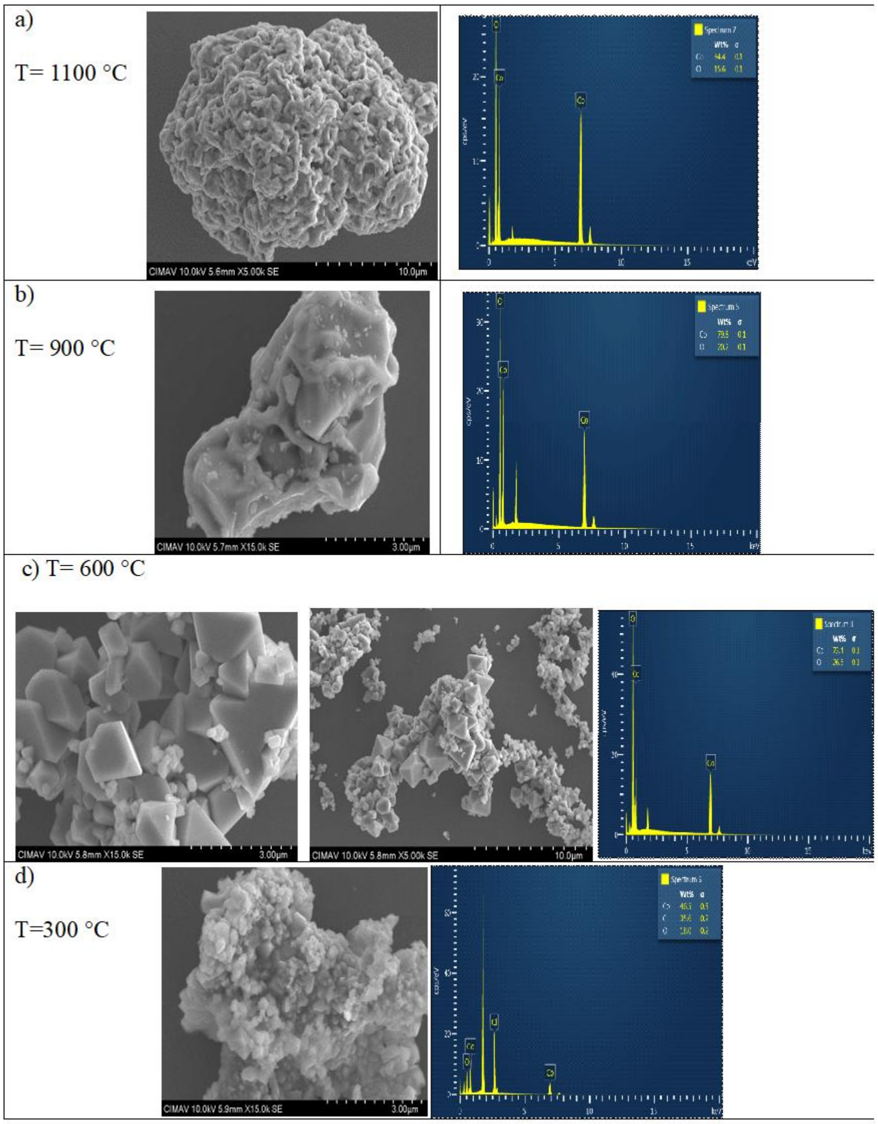

Figure 1. a) , b), c) and d) of Co3O4 at different calcination temperatures

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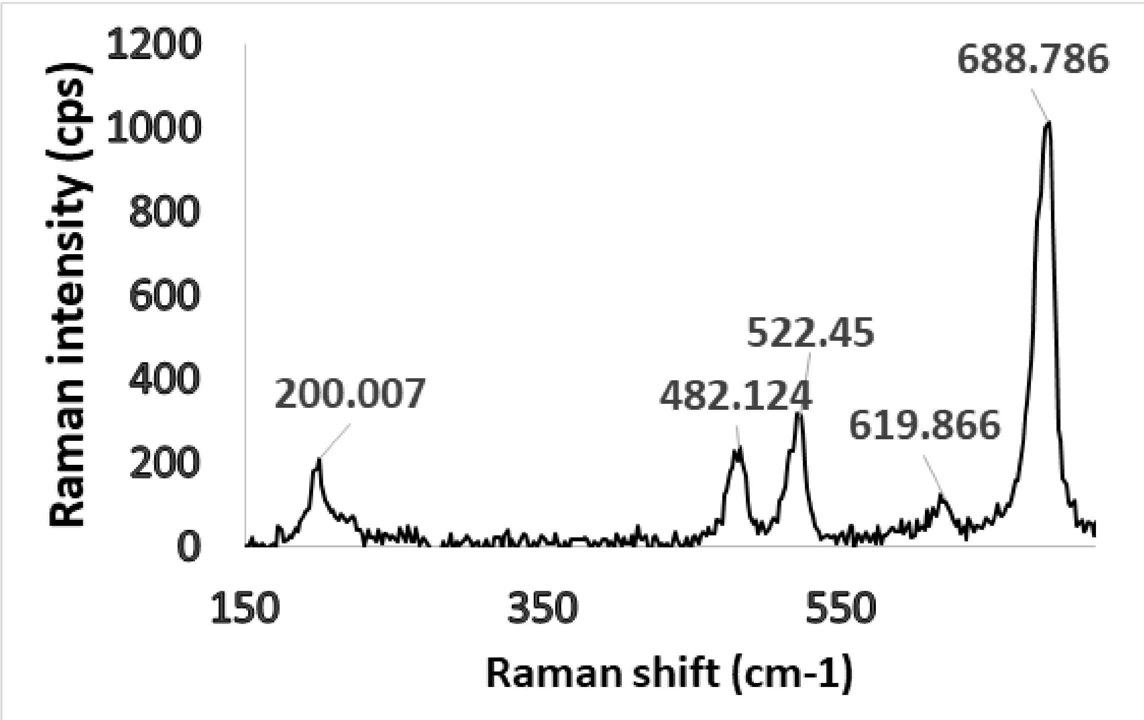

Figure 2. Raman spectrum of Co3O4 at 600 °C

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