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Gel-Combustion synthesis to obtain Co_3O_4 nanopowders for solar selective surfaces

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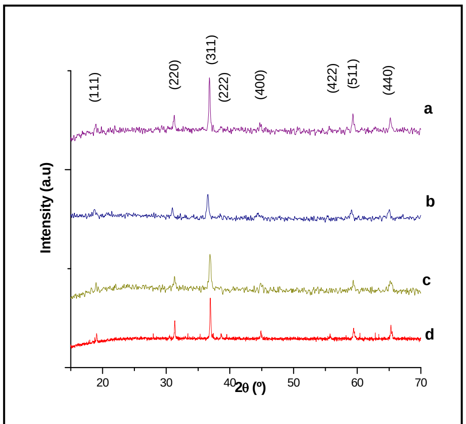
Abstract – Selective solar paints based on Co_3O_4 solid particles were prepared. In this study, two combustion routes for synthesis of Co_3O_4 using lysine and EDTA, as fuels, were used. Co_3O_4 nanopowders were characterized by X-ray diffraction (XRD), scanning electron microscopy (SEM), transmission electron microscopy (TEM) and BET specific surface area. The Co_3O_4 particles showed different S_{BET}, with dimensions ranging from a few hundred nanometers to several microns. However, the Co_3O_4 structure was always similar.

It is generally understood that the current pattern of energy supply is non-sustainable and the harnessing of solar energy is bound to play a major role in near future. A solar collector consists of a particular heat exchanger that transforms solar radiant energy into heat. An important part of the flat-plate of solar collector is the “black“ solar energy-absorbing surface which transfer the absorbed energy to a fluid. Solar selective surfaces improve the performance of solar collectors. A wide variety of techniques and coating materials have been used to obtain such selective surfaces, such as cobalt oxide films obtained by spray pyrolysis (1) or by sol–gel process (2). In order to obtain solar selective paints, in this study Co_3O_4 solid particles were prepared and characterized. The performance of the paint dispersion depends upon pigment particle size distribution and particle size (3). The use of combustion synthesis to obtain Co_3O_4 nanopowders has been difficult to achieve (4). Particularly, gel-combustion processes proved to be useful for the synthesis of nanomaterials with high specific surface areas and excellent compositional homogeneity by simple and low cost procedures (5).

In this study, two combustion routes for the synthesis of Co_3O_4 nanopowders using lysine and EDTA, as fuels, are presented. *i).*Samples were prepared by using a stoichiometric process requires a EDTA/Co molar ratio of 0.17 (**a**) and lysine/Co molar ratio of 0.26 (**b**); *ii).* Samples prepared using nitrate- and fuel-rich process required a EDTA/Co molar ratio of 1.12 (**c**) and lysine/Co molar ratio of 1.32 (**d**). The samples were characterized by S_{BET}, X-ray diffraction (XRD), scanning electron microscopy (SEM) and transmission electron microscopy (TEM). S_{BET} of samples were: **a**) 22.87; **b**) 13.40; **c**) 29.34 and **d**) 7.96 m^2/g, respectively. The **a** and **c** samples, as example, have similar specific surface area but different morphology (Fig.1). This is surely due to different EDTA/Co ratio which determines a different reactivity level at the combustion stage in both syntheses. On the other hand, the XRD patterns are similar to those of the traditional Co_3O_4 nanopowders (Fig. 2).



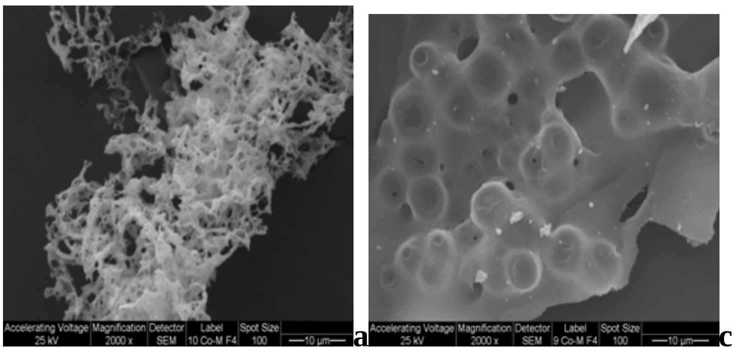


Figure 1: SEM micrographs of **a** and **c** synthesized samples.

Figure 2: XRD pattern of **a, b, c** and **d** samples.

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