Structure and Morphology Study of Copper/Copper Oxides Nanoparticles

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Nanoparticles have great attention due to its peculiar properties. Copper and copper oxide NPs (Cu/Cu₅O-NPs) are of interest due to their low cost and their relatively high physical and chemical stability. These particles have antifungal properties [1] but it is necessary to optimize low and effective doses. At this time, there is a discussion about its antifungal activity, due to the literature still discuss about the oxidation state of copper [2]. However, besides the oxidation state of copper, the size and morphology of the NPs play an important role in the antifungal effect. An adequate choice of the copper NPs properties, such as the oxidation state, size, etc. can improve their antifungal activity. In this work, by means of TEM and XRD was studied different morphologies and compounds.

Copper and copper oxide nanoparticles were synthesized by an eco-friendly method. 50 mL of CuCl₂·2H₂O (0.1 M) was mixed with 50 mL of PEG 8000 (0.038 M). Then, under stirring 50 mL aqueous solution of ascorbic acid (0.2 M) mixed with NaOH (1 M) was added. Afterward, 50 mL of NaBH₄ solution at different concentrations (0.1, 0.5, 1, 1.45 M) were added. The reaction was stirred at room temperature for 30 min at open atmosphere. After this time, a precipitate brown dark color is formed, which indicates the formation of the Cu/Cu₅O nanoparticles. The obtained samples were named according to different NaBH₄/Cu(II) molar ratios. Morphology and structure changes was studied by TEM and XRD techniques.

Fig. 1 shows the morphology change of as synthesized nanoparticles. For NP1 the size of the particles is small, round shape (Cu₂O) and truncated octahedrons (Cu) are observed (Fig. 1a). On the other hand, the NP2 samples showed small round particles corresponding to CuO, bigger truncated octahedrons (Cu), and some laminated particles, which correspond to CuO (Fig. 1b). For the NP3 small round (Cu) and laminated (CuO) particles are observed (Fig. 1c). For NP4, there is only laminated particles (CuO) observed (Fig. 1d). From these images, could be conclude that the concentration of NaBH₄ in the synthesis also controls the morphology and size. Table 1 shows the crystal size and compound percentage content for each synthesis, determine from Rietvel refinement of X-ray diffraction patterns [3].

References:

[3] This work was supported by the research project FORDECYT 292399.
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<th>Sample</th>
<th>Cu Grain size (nm)</th>
<th>%</th>
<th>Cu₂O Grain size (nm)</th>
<th>%</th>
<th>CuO Grain size (nm)</th>
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<td>13</td>
<td>97.3</td>
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**Table 1.** Size of the crystallites and composition obtained from Rietveld refinement

**Figure 1.** Copper and copper oxide nanoparticles a)NP1, b)NP2, c)NP3 and d)NP4.