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The solvatothermal synthesis of copper nanoparticles: the role of different additives

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Abstract – Copper nanoparticles (CuNPs) were prepared by the solvatothermal decomposition of copper acetate in diphenyl ether. The isolation of CuNPs was difficult because of copper's propensity for oxidation, which result in copper oxide after exposition to air. The presence of additives, such as oleylamine, oleic acid or 1,2-dodecanediol, in the solvatothermal synthesis plays a key role to prevent nanoparticles oxidation, allowing the isolation of stable CuNPs. Those additives act as capping ligands, but seem to be not necessary for metal reduction during the solvatothermal synthesis. The CuNPs were characterized using TEM, XRD, and UV-visible techniques.

In this study, samples of copper nanoparticles (CuNPs) have been synthesized by the solvatothermal decomposition of copper acetate in diphenyl ether in the presence and absence of additives. The solvatothermal synthesis of NPs has received attention as a reliable synthetic route to NPs of controlled size and shape [1,2]. Different additives, such as oleylamine, oleic acid and a 1,2-diol, are usually added, but the role of these additives is not always clearly established. Most of the time those reagents are regarded as reducing and capping agents.

A typical solvatothermal synthesis of CuNPs was first performed by refluxing a solution of copper(II) acetate, oleylamine, oleic acid and 1,2-dodecanediol in the high boiling point solvent diphenyl ether. The color of the mixture changed from blue to red, which is a characteristic of nanosized copper particles. In this synthesis, very stable CuNPs were isolated as characterized by TEM and XRD. However, in the absence of each one of the additives (oleylamine (OAm), oleic acid (OA) and 1,2-octanediol (Diol), CuNPs were always obtained. It is worthy to comment that the synthesis performed without all of those additives, only by refluxing a solution of Cu(II) acetate in diphenyl ether, resulted in copper oxide NPs as shown by DRX. Actually, most probably the metal reduction occurred, but in the absence of capping ligands, the "naked" CuNPs oxidized during the workup procedure. The presence of additives, such as oleylamine, oleic acid or 1,2-dodecanediol, in the solvatothermal synthesis plays a key role to prevent nanoparticles oxidation, allowing the isolation of stable CuNPs. Those additives act as capping ligands, but seem to be not necessary for metal reduction during the solvatothermal synthesis. The XRD patterns of all samples are shown in Figure 1.

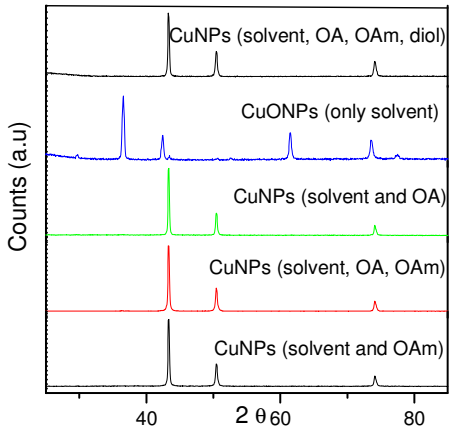

Figure 1: X-ray diffraction pattern of CuNPs and CuONPs. (OA=oleic acid, OAm=oleylamine, diol=1,2-octanediol)

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References

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