Recycling Copper Nanoparticles from $CuCl_2$-Containing Waste Etchants by Using Microemulsion for Printed Circuit Board Industry

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Abstract

At present, over 60 million liters per year of 10-15 % copper-containing waste etchants (CCWEs) generated from printed circuit board (PCB) manufacturing are disposed of in Taiwan. The CCWEs are mainly composed of copper chloride, hydrochloric acid, and water. Since the disposal of the etchants without proper treatment has posed an environmental problem, the unacceptable and expensive separation or storage method has been previously used but not effectively and successfully. Therefore, resource recovery of these undesired waste etchants in the form of high-purity metallic copper by microemulsion route would be economically and environmentally attractive in the future. Experimentally, the Cu nanoparticles were recovered from CCWEs by microemulsion at controllably ambient temperature and pressure. The properties of nanophase metallic copper was further analyzed by using XRPD, FE-SEM, TEM or X-ray absorption near edge structure/extended X-ray absorption fine structure (EXAFS/XANES) spectroscopy. From the FE-SEM or TEM microphotos, hexagonal-like or rectangular shape Cu crystalline nanoparticles with diameters of approximately 20-50 nm were found. Moreover, the pH values increased with the decreasing particle sizes of Cu nanoparticles in the synthetic processes. The XRPD patterns showed the nanoprecipitates have metallic copper and Cu_2O crystal structures. Existence of the Cu(0) or Cu(I) was also confirmed by XANES or XPS spectroscopy. The metallic Cu and Cu_2O nanoparticles with a cubic lattice structure were observed by EPR spectra. The as-synthesized copper nanoparticle with a Cu-O (Cu-(O)-Cu) bond distance of 1.85 ± 0.02 Å (2.69 ± 0.02 Å) and a coordination number of 1.39 ± 0.25 (3.5 ± 0.25) was also measured by EXAFS spectroscopy.

Keywords - copper oxide nanoparticle, copper-containing waste etchant, printed circuit board, microemulsion, resource recovery.

References

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