



In situ X-ray absorption spectroscopic studies of copper in a copper-rich sludge during electrokinetic treatments

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Speciation of copper in the electrokinetic treatment of a high-copper-concentration chemical mechanical polishing (CMP) sludge has been studied by in situ extended X-ray absorption fine structure (EXAFS) and X-ray absorption near edge structure (XANES) spectroscopy. The main copper species in the sludge are $\text{Cu}(\text{OH})_2$ (73%), nanosize CuO (20-60 nm) (14%) and CuO (13%), which are observed by the least-square fitted XANES spectroscopy. The average bond distance and coordination number (CN) of Cu-O are 1.96 Å and 3.5, respectively. Under the electrokinetic treatment (5 V/cm) for 120 min, about 85% of copper are dissolved and formed $[\text{Cu}(\text{H}_2\text{O})_6]^{2+}$ in the electrolyte, and 13% of which are migrated and enriched in the cathode. It is worth to note that the copper nanoparticles in the sludge can also migrate to the cathode under the electric field. By in situ EXAFS, it is found that during the electrokinetic treatment the bond distance and CN of Cu-O are increased by 0.1 Å and 0.9, respectively.