OC-15: Preliminary Electrochemical Study for Copper Electrodeposition from Sonicated Deep Eutectic Solvent (DES)

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The issue of recovery of noble and criticism metals from industrial effluents is more relevant than ever for both economic and environmental reasons (Bourgois (2000)). Copper is an essential element in the industrial world and its consumption is increasing because it is one of the major component of printed circuit boards for the electronic industry and microelectronics. Copper waste mainly comes from two sources: surface treatment baths (electroplating effluent) and acid leachate from reprocessing of electronic waste. E-Waste contains about 20 % of copper associated with heavy metals, precious or common ones (Masavetas (2009)) . The target metal for this study is copper: It makes up for at least one third of the device price, and using WEEE copper secondary resource becomes essential for ecological and economical reasons.

The recovery process includes a succession of mechanical pretreatment (grinding) and thermal (incineration, melting oxidation) treatments. Then metal extraction can be achieved by two ways, either pyrometallurgical or hydrometallurgical. By comparing the two technologies, the hydrometallurgical method appears more suitable for precious metal and copper recovery (Andrews (2000)). In such processes, the leaching of copper and other metals requires the use of leaching agents, amongst which the most widely used, is cyanide leaching, especially in the surface treatment industry and in the mining industry for gold and silver recovery from ores. The review of Cui and Zhang (Cui (2008)), point out the drawbacks, mainly environmental if considering cyanide or acidic liquid wastes, of each leaching method.

In such context the need for sustainable hydrometallurgical processing using environmentally harmless leaching solvent appears really challenging. Ionic liquids (Ils) are widely investigated in the field of "Green Chemistry", particularly in electrochemistry as alternative solvents for the electrodeposition of metals (Abbott (2006), Endres (2006)). The final step of the recovery process is always the electrolysis of the ionic liquid with the theoretical advantage of a better selectivity and an increased deposition yield. Compared to organic ILs, DES are biodegradable and economically viable to large scale processes. The electrodeposition of copper is easy to implement, however when the concentration of ions Cu^{2+} decreases and also because of the DES viscosity, the mass transfer is quite low and as a result the electrodeposition kinectics is significantly reduced. The use of ultrasound is known to be an effective stirring method to promote mass transport to the electrode and thus the rate of recovery (Pollet (2008)).

The present study investigates the influence of ultrasound (20kHz) on the reduction kinectics of copper (II) ions (15 mM) in a Deep Eutectic Solvent (DES) made of a mixture of choline chloride and ethylene glycol (in 1:2 proportion). To complete the study a comparison with results obtained in aqueous solvent (HCl 0,01M+15mM $CuCl_2$) is performed. The electrochemical study allowed to determine the mechanism for Cu^{2+} reduction in DES which appears to be a two steps mechanism probably involving copper chloride complex. The kinetics parameters of Cu^{II} ions reduction were determined in the two types of media (k° the apparent heterogeneous rate constant and kd: the mass transfer coefficient). These constants were measured as a function of the following experimental parameters: temperature, viscosity of the DES (obtained by addition of a thinner) and ultrasound stirring.

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