Bioelectrochemical metal recovery for metal production recycling and remediation

Motivation

Nowadays global metal primary resources are rapidly dwindling, increasing the costs of these metals. Also, the mining industries in Europe produce approximately 14 million of tons per year of hazardous mineral waste. For that reason, innovative and clean environmental metal extraction techniques are required to raise mining sustainability. Bioelectrochemical metal recovery is the new method for production of pure metals, to recycle them from wastes and to remediate contaminated areas.

Technological challenge

The bioelectrochemical process to recover metals involves two redox reactions. The anode reactions oxidize organic matter or sulphur compounds from waste streams using bacteria as catalysts. The cathode reaction uses the electrons from the anode to reduce dissolved metals to their metallic form. The charge in the solution is balanced by a membrane between the electrodes. Both reactions combined can produce electricity.

Biological catalysts have several advantages over chemical catalysts (e.g. platinum): they are cheap, active at ambient temperatures and are renewable. Therefore, we investigate the use of microorganisms to catalyze metastable sulphur rich compounds oxidation on the anode. The main focus of this project is the cathodic reduction of the metal ions into their metallic form.

The principle of these bioelectrochemical devices were recently proven for copper recovery in a Microbial Fuel Cell (MFC). Besides copper other metals (zinc, nickel, cobalt, iron and lead) will be considered.

The technological challenge is to further investigate and develop different types of biological anodes, different substrates for the cathode and studying the limiting factors of the cell by electrochemical techniques such as Cyclic Voltammetry or Electrochemical Impedance Spectroscopy, aiming to build a device for metal recovery at different mining sites and metal industries.

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