Electrolytic nature of molten sulfides electrolyte

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The processing of sulfide ores is today necessary to provide some of the key metals (copper, lead or nickel) as well as strategic metals such as molybdenum or rhenium. Copper as an example was the first metal processed by mankind, and remains an essential commodity for society. The chemical principle behind industrial smelting of sulfide ores is the selective oxidation of the sulfide ions (S^{2-}) by oxygen to form copper metal and sulfur dioxide (SO_{2}). Therefore, this pyrometallurgical approach unavoidably results in the production of SO_{2} as a by-product of copper smelting, and requires numerous steps from concentrate to high purity metal. Overall the process results in large capital investments and has significant environmental consequences.

It is envisioned that greater flexibility in the stream of strategic metals could be obtained if new extraction methods with lower capital, operating and environmental costs were available. One chemical alternative to smelting is the direct decomposition of copper sulfide into copper and elemental sulfur. This approach could be conducted using electricity as a driving force, as practiced industrially for copper (from oxide via aqueous electrolyte) or aluminum (from oxide via molten fluorides electrolyte). The idea of electrolysis of molten sulfide in a sulfide electrolyte has been proposed by our group to expand the solubility of sulfide in electrolyte and elemental sulfur as anodic product.

This talk covers the thermodynamic consideration and selection process to design an appropriate electrolyte. The supporting electrolyte should be both thermally and electrochemically stable at the operating condition. Besides, the electrolyte should have proper transport properties such as viscosity and ionic conductivity. However most of molten sulfides are known to be semiconductors and the main question to be addressed is “Can a molten semiconductor be used as a supporting electrolyte in these process?”. 