O23. Prospects of metallurgical waste valorisation by the electroreduction of $Fe_{2.3}Mg_{0.7}O_4$ ceramics to Fe

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The alkaline electrochemical reduction of iron oxides arises as carbon-lean alternative technology for steelmaking, with lower electric energy consumption [1]. Moreover, the valorisation of metallurgical waste with high iron content represents an interesting approach for decreasing the over-exploitation of natural resources such as iron ores. In this scope, the present work consists on the electrochemical reduction of a magnesium ferrospinel material into iron under strong alkaline conditions, for studying the prospects of using a metallurgical waste as an iron oxide source. Porous ceramic samples of $Fe_{2.3}Mg_{0.7}O_4$ were processed based in the ceramic suspensions of powders with water, followed by the emulsification of liquid paraffin to create highly-porous cellular structures as in [2]. The electrochemical reduction tests were performed both in bulk ceramic samples and in powder suspensions after crushing the ceramic pieces in the latter case. All electrochemical tests occurred at 90 °C, at strong alkaline conditions (10 M, NaOH), where Ni grids were used as substrate. A Pt wire was used as counter electrode (CE) and a Hg|HgO|NaOH (1 M) electrode as a reference electrode (RE). Cyclic-voltammetry curves, chronoamperometry curve performed at potentiostatic mode (-1.14 V, 6 h) and electrochemical impedance spectroscopy (EIS) were recorded by a VersaSTAT 4 (AMETEK) potentiostat. Combined studies of XRD/SEM/EDS proved the presence of Fe crystals in both electrochemical systems. Despite a magnesium hydroxide phase was also observed in both cases, blocking the progression of the electroreduction, a 55% of Faradaic efficiency was attained in the bulk system. The magnesium phase showed to have a significative impact during the electroreduction in the suspension mode, lowering the efficiency to 20%. Nevertheless, the electroreduction to Fe was proved in both systems and the reduction mechanisms were studied. Low content of magnesium impurities can be considered for the valorisation of metallurgical waste by the electroreduction technology.

References

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