Simulation of the electrowinning process using green renewable energy sources for industrial iron production.

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Nowadays, despite the rising demand of light materials, iron, namely steel, plays a crucial role in the modern world. Today, the EU is the 2nd largest steel producer globally with a production of 166 million tons of crude steel in 2015. For the time being, the main conclusion is that there are no economically feasible steelmaking technologies available that have the potential to meet the EU's climate and energy targets for 2030. At best, a 15% decrease in the overall CO2 intensity of the sector could be achieved throughout the widespread dissemination of technologies that could reasonably become cost-effective in the future. Therefore, breakthrough technologies are urgent and indispensable. An electrochemically based route is being already developed as a candidate for an alternative to conventional steelmaking processes for CO2-free iron production. Direct electrochemical reduction of iron oxides has been gaining attention as a process allowing in-situ reductions at the cathode, under strong alkaline media.
To find the feasibility of operation with long term interruptions (e.g. to seek preferential operation in low tariff periods), the experiments were performed with step changes in current rather than in potential. The selected experimental conditions comprise cycles with shut down interruptions, and other cycles with an impinged residual current (10%) to ensure cathodic protection. An important difference in deposit microstructure can be observed in subsequent interruption stages without and with cathodic protection. Shut down causes an increase in potential in the re-oxidation range and deeper decrease of potential in the cathodic range on resuming deposition, possibly implying an increase in power consumption. Nevertheless, there are no significant differences in Faradaic efficiency, possibly because potential remains in the safe range to suppress the evolution of hydrogen. Thus, it seems that microstructural changes are the prevailing effect of interruption without cathodic protection in these ranges of potential/current density. Coarser grain sizes observed for unprotected shutdown interruptions may be related to surface re-structuring of the top layer, by re-oxidation during the unprotected interruption and subsequent reduction. Investigation of the cross-sections of the deposits in both regimes doesn't reveal any layer structure. The only deposit where layers were observed was obtained in the regime, where the cathodic protection step lasted 8 times longer than the deposition.