

Direct Electrolytic Reduction of Hematite Pellets in Alkaline Electrolyte for Iron Production

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INTRODUCTION

The industrial production of iron and steel contributes to ~8 % of the global CO₂ emissions. Electrolysis using an inert oxygen evolving anode offers in principle a very low CO₂ impact. However, today the generation of electricity leads to major CO₂ emissions. Development of electrolysis technologies for iron may give possibilities for producing special iron products including alloys.

Previous studies demonstrated that iron was produced through a direct solid phase cathodic electrodeoxidation of hematite particles suspended in an alkaline electrolyte [1]. A direct electrolytic reduction of pellets of solid hematite may then be feasible.

EXPERIMENTAL

The hematite powder pellet (about 1 g) was manufactured by mechanical pressing followed by sintering. The pressed pellet was put in an alumina crucible and was sintered in air in an electric furnace at 800 °C for 3 hours.

Electrolysis was carried out at 110 °C. The experimental set-up is shown in Fig. 1. The electrolyte was a 50 wt% NaOH - 50 wt% H₂O solution contained in a cylindrical Teflon crucible. The highly concentrated solution provided the advantages such as a high conductivity, suppressed H₂ evolution reaction, and possibility to apply higher temperature without considerable loss of water. A rectangular nickel mesh was attached to the wall of the container and was used as the inert anode for oxygen evolution. The powder pellet was suspended in the electrolyte corresponding to the geometric center of the anode for the sake of uniform current distribution. A Pt wire was embedded through the pellet.

RESULTS

Fig. 1 shows an optical image of the pellet after sintering at 800 °C for 3 hours and the reduced pellet after electrolysis at 300 mA current for 29,5 hours. The geometry of the pellet was a thin cylindrical tablet of 10 mm in diameter and about 4 mm in thickness. The platinum wire embedded in the pellet was used to initiate multiple reaction sites throughout the body of the oxide. A rather shiny metallic pellet was produced after prolonged electrolychemical reduction. Apparently the hematite was completely converted into the iron metal.

Diffusion of oxygen ions in the solid oxide phase was probably the rate-determining step in the electrochemical reduction process. This fairly simple FFC Cambridge type process [2] shows a high potential for the industrial production of pure electrochemical iron and iron alloys.

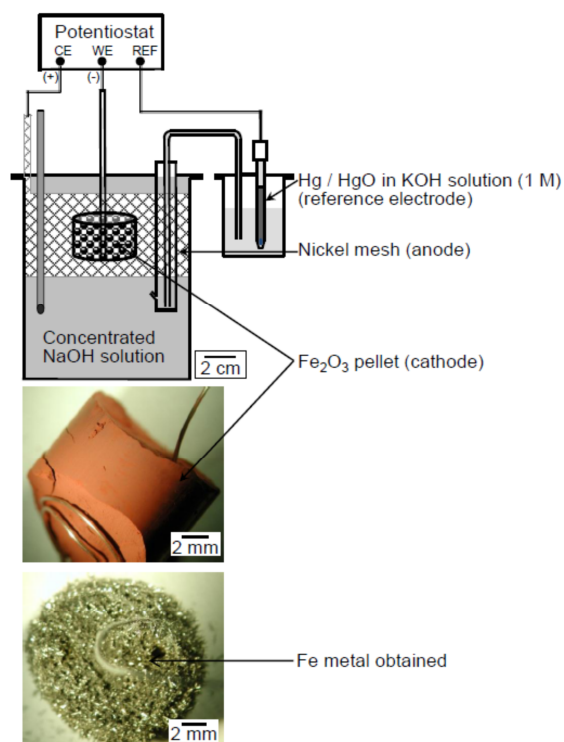


Fig. 1. Schematic drawing of the experimental step-up, optical images of the sintered pellet and the reduced pellet.

REFERENCES

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