

ELECTROCHEMICAL BEHAVIOR OF Fe-Fe₃O₄-NaOH-O₂ ENERGY STORAGE ELECTRODE SYSTEMS

Potapenko O. V., *Kravchenko O. V.*, Pershina K. D.
Inter-Agency of Electrochemical Energy Systems NAS of Ukraine
KravchenkoAlex@i.ua

Iron oxide mixtures are well known as promising electrode materials for secondary batteries. Interest to such systems has been driven by incentives to develop low-cost, environmentally friendly and ability to recharge systems. The charge capacity of Fe- air battery is formed due to possibility of the iron to realize redox reactions with oxygen in wide range of potentials in aqueous solutions.

Experiment consisted of two stages: 1 – for avoid passivation of iron (rusting) and reduce hydrogen evolution at the electrode surface during charging the working electrode was prepared from powdered materials containing metallic iron or iron oxides (80 % of a mixture of Fe and Fe₃O₄; 10 % – acetylene soot and 10 % – Polytetrafluoroethylene); 2 – electrochemical behavior of Fe-Fe₃O₄ was studied using cyclic voltammetry (CVA) in alkaline media. Measurements were taken in open air 3-electrode cell: counter electrode (oxidized graphite), working electrode (Fe-Fe₃O₄) and reference electrode (Ag/AgCl).

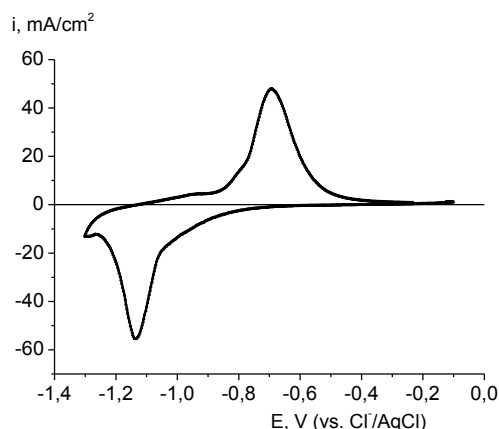


Fig. 1. CVA of the Fe-Fe₃O₄ electrode ($v = 1 \text{ mV/s}$, $t = 25^\circ\text{C}$, 5M NaOH)

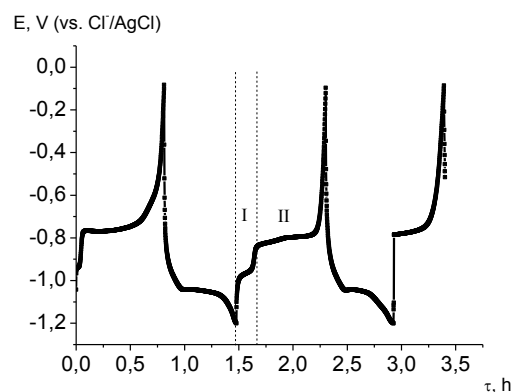


Fig. 2. Charge-discharge curves of the Fe-Fe₃O₄ electrode ($i = 5 \text{ mA/cm}^2$, 5M NaOH)

The CVA study determined range of the potential window of the iron-air system, it be $E = -1.28 \text{ V}$ (Fig. 1). It is slightly lower than that of the iron–nickel oxide cell of 1.41 V , but air-breathing electrode can increase the energy density due the realization of five redox reactions with participation of ironcontent compounds. Analysis of the standard potentials of electrode reactions in aqueous solutions show that the charge / discharge process depends on the redox transformations of the pair $\text{Fe}^0/\text{Fe}^{2+}$ ($E = -0.44 \text{ V}$ via SHE) and $\text{Fe}(\text{OH})_2/\text{Fe}^0$ ($E = -0.88 \text{ V}$ via SHE) and on the concentration of dissolved oxygen and carbon dioxide (Fig. 1.2). Dissolved carbon dioxide promotes the formation of FeCO_3 , which is reduced to Fe^0 at $E = -0.756 \text{ V}$ (SHE). The obtained specific capacitance of Fe-Fe₃O₄ electrode was $80\text{--}100 \text{ mAh/g}$. The observed increasing of resistance and a decreasing of specific capacity during cycling is connected with two main factors: 1 – with decreasing of the oxygen concentration; 2 – with increasing of the amount of carbonates, which blocking the surface of the electrode.