Investigation of Amorphous Ni-base Alloys as Cathode for Hydrogen Evolution using Electrochemical Methods and EC-STM

T. Rauscher, Technische Universität Dresden, Institute for Materials Science, Dresden, Germany;

C.I. Müller, A. Schmidt, T. Schubert, T. Weißgärber, Fraunhofer Institute for Manufacturing Technology and Advanced Materials (IFAM), Branch Lab Dresden, Germany;

B. Kieback, TU Dresden, Institute for Materials Science and Fraunhofer Institute for Manufacturing Technology and Advanced Materials (IFAM), Branch Lab Dresden, Germany;

L. Röntzsch, Fraunhofer Institute for Manufacturing Technology and Advanced Materials (IFAM), Branch Lab Dresden, Germany;

In view of hydrogen production from renewable energy sources without CO_2-emission, alkaline water electrolysis is an important method to produce highly pure hydrogen at large scale [1, 2, 3]. However, this method of hydrogen production remains costly. In order to enhance the efficiency of the process and to reduce the costs of the electrolytic hydrogen production new electrode materials are required. Therefore, amorphous materials represent a non-traditional class of electrode materials with good electrocatalytic properties [4], high corrosion stability [5] and low manufacturing costs [4].

In this contribution, amorphous Ni-base alloys produced via melt spinning were investigated in order to enhance the electrocatalytic activity of electrode materials for hydrogen evolution reaction (HER). The structural and morphological characterization of the electrode materials was performed by XRD and SEM, respectively. However, the main focus was the electrochemical investigation of these materials compared to nickel by cyclic voltammetry, overpotential and steady-state polarization measurements. It can be shown, that an optimized alloy composition as well as an electrochemical pretreatment results in an improvement of the electrode materials for the HER.

The activity of the HER is strongly related to the surface state of the electrode at the micro- and nano-scale. According to this assessment, electrochemical scanning tunneling microscopy (EC-STM) will be used to study in-situ the electrode/electrolyte interface and to establish the structure-properties relationships of the electrode material. The preliminary EC-STM investigations demonstrate that significant surface changes on selected amorphous Ni-base alloys compared to polycrystalline nickel occur in the potential range close to the open circuit potential. Furthermore, EC-STM experiments were conducted to analyze the ability and the limiting conditions for the scanning probe technique in the potential range of the HER.

References

[1] Shan, Z. et al (2008), Int. J. Hydrogen Energy 33(1), 28 -33
[2] Zeng, K. & Zhang, D (2010), Prog. Energy Combust. Sci. 36(3), 307-326
[3] Birry, L. & Lasia, A. (2004), J. Appl. Electrochem. 34, 735-749.
[4] Kreysa, G. & Hakansson, B. (1986), J. Electroanal. Chem. 201(1), 61-83.
[5] Alves, H. et al (2003), Corros. Sci. 45(8), 1833-1845