STUDY OF ZRTICUNIBE BULK AMORPHOUS ALLOY ON ELECTROCATALYSIS PROPERTY

G.J. SHAO, X.J. QIN, CH. YANG, Q. JING, R.P. LIU, W.K. WANG

In this article, the electrocatalysis property of ZrTiCuNiBe bulk amorphous alloy used as electrode material in electrolysing NaCl solution was studied carefully. The results shows that ZrTiCuNiBe bulk amorphous alloy exhibits excellent catalytical property during the course of electrolysing NaCl solution compared with graphite electrode material, and can be used as negative pole material of electrolysing NaCl solution.

1. Introduction

In the long history of chloric alkali industry the method of electrolysing NaCl solution was adopted to prepare chlorine and NaOH. To lower the polarization of electrode and save electricity, it is important that electrode material exhibits an excellent electrocatalysis property on precipitation reaction of chlorine and hydrogen. That is to say, it is necessary to reduce the electrical voltage in precipitation reaction of chlorine and hydrogen. In the past graphite material was used as anode in electrolytic reaction. Although graphite anode possesses a good catalytical property, yet its expectant life is short. In the late 1950's, new metallic anodes were invented in chloric alkali industry which has a better electrocatalysis property and a longer expectant life. To further improve voltaic efficiency and save electricity, effort of exploring new electrode material with higher electrocatalysis property has long been made.

$Zr_{41}Ti_{14}Cu_{13}Ni_{10}Be_{22.5}$ bulk amorphous alloy is used as anode and cathode material to electrolyse saturated NaCl solution in the present work. Its electrocatalysis property was studied in comparasion with graphite electrode.

2. Experimental methods

To study the electrocatalysis property and the efficiency electrolysing NaCl solution and $Zr_{41}Ti_{14}Cu_{13}Ni_{10}Be_{22.5}$ bulk amorphous alloy and graphite were respectively utilized as anode and cathode to electrolyse saturated NaCl solution at the same conditions. In this way, the electrode property of $Zr_{41}Ti_{14}Cu_{13}Ni_{10}Be_{22.5}$ bulk amorphous alloy can be understood by comparasion with the polarization curves of the two different electrodes.

In the experiment, electrode plates of bulk amorphous alloy and graphite have the same surface in order to make it easier to compare. Epoxy resin was utilized to encapsulate electrode. Epoxy resin and second diamine were mixed completely by a ratio of 20 to 1. A polished bulk amorphous alloy was connected with lead. Then the amorphous plate as well as the joint were packed and enclosured. After solidification of epoxy resin, the tested surface of the amorphous specimen was polished by sand paper to expose its surface. In this way, only the polished surface was contacted with solution during electrolysing saturated NaCl solution. In the same way, graphite electrode with the same exposed area was prepared.

Electrochemical workstation of CHI 660A was utilized to test the polarization curves of anode and cathode of bulk amorphous alloy electrode and graphite electrode in saturated NaCl solution. Reference electrode was saturated calomel electrode.

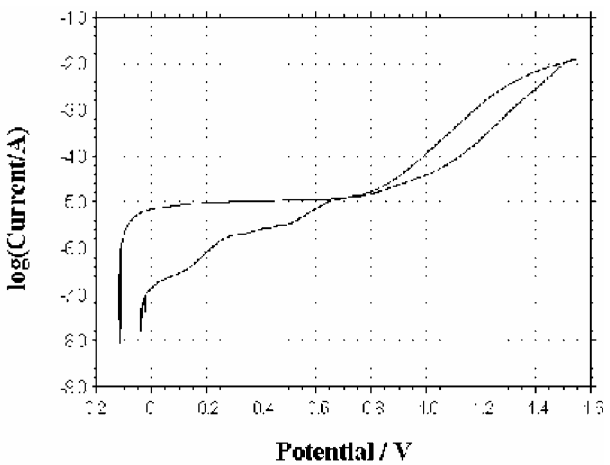

Fig.1. Cathode polarization curves of the surfaces of bulk amorphous alloy and graphite

3. Experimental results and discussions

At the process of electrolysing saturated NaCl solution by the cathode of $Zr_{41}Ti_{14}Cu_{13}Ni_{10}Be_{22.5}$ bulk amorphous alloy and graphite, electrode potential of the two electrodes when hydrogen started to appear was in a range of –0.7 to –0.8 volt as shown in Fig.1. Nevertheless, after the reaction began, electrode potential of $Zr_{41}Ti_{14}Cu_{13}Ni_{10}Be_{22.5}$ bulk amorphous alloy was a little bit lower and its over-potential was a little bit smaller at the same electric current density. In other words, by using $Zr_{41}Ti_{14}Cu_{13}Ni_{10}Be_{22.5}$ bulk amorphous alloy as a cathode a much higher electric current could be gained at the same potential than that of graphite. Because of this advantage, the bulk amorphous alloy can be used to improve procreative efficiency effectively and save electricity.

Figure 2 shows $Zr_{41}Ti_{14}Cu_{13}Ni_{10}Be_{22.5}$ bulk amorphous alloy can obtain much higher electric current than that of graphite. Accordingly, it can be concluded that $Zr_{41}Ti_{14}Cu_{13}Ni_{10}Be_{22.5}$ bulk amorphous alloy exhibits more excellent electrode property than that of graphite. However, after a long time of electrolyzation, an amount of corrosion can be found on the anode surface of $Zr_{41}Ti_{14}Cu_{13}Ni_{10}Be_{22.5}$ bulk amorphous alloy. Therefore, the composition of the alloy is needed to be adjusted if bulk amorphous alloy was used as anode material.

4. Conclusions

ZrTiCuNiBe bulk amorphous alloy exhibits excellent electrocatalysis property during electrolysing NaCl solution. A better performance is provided when it is used as cathode material.

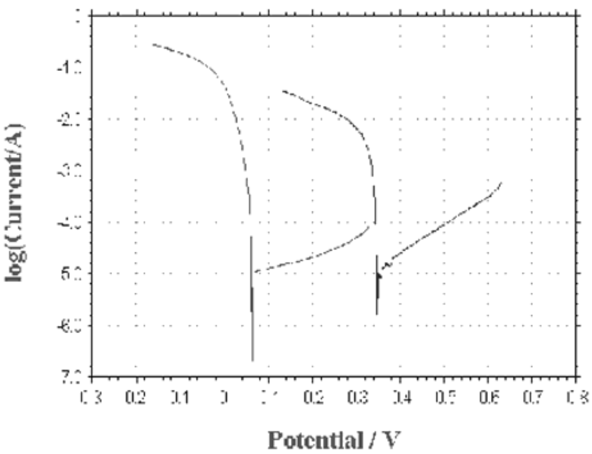

Fig.2. Zincous polarization curves of bulk amorphous alloy and graphite

REFERENCE

1. A. Inoue. Bulk Amorphous Alloys TRANS TECH PUBLICATIONS LTD1998.
2. W.H. Wang, Q. Wei and S. Friedrich: Phys.Rev.B 57(1998)8211.
3. A. Inoue. Bulk Metallic Glasses, Vol.6 in Materials Science Fundations, (Trans. Tech.Ltd.1999).
4. A. Wiedenmann, U. Keiderling, M. P. Macht, and H. Wollenberger. Mater.Sci. Forum 71, 225-227, (1996).
5. J. Zhu, M.t, Clavaguera-Mora, and N. Clavaguera. Appl. Phys.Lett.70, 1709 (1997).
6. A. Van den Beukel and J. Sielsma. Mater.Sci.Eng, A86, 179 (1996).
7. C. A. Volkert and F. Spaepen. Acta Metall.37, 1355 (1989).

Yanshan university QinHuangDao China 066004

Article is delivered in editing 9.07.2002