ELECTRODE FOR HYDROGEN EVOLUTION

Tomáš Knotek
Doctoral Degree Programme, FEEC BUT
E-mail: xknote06@stud.feec.vutbr.cz

Supervised by: Jiří Vondrák
E-mail: vondrakj@iic.cas.cz

ABSTRACT

Suitable material for electrode for hydrogen evolution was measured into 1M KOH at room temperature. The electrochemical properties was studied on Fe, Ni, non-corroding steel, nickel coated Fe, nickel-zinc alloy coated Ni (Ni-NiZn, leached Zn) and nickel (under layer)/nickel–zinc alloy coated (top layer) Fe electrodes (Fe-Ni-NiZn, leached Zn). Experiments were carried out in a three-electrode cell with a capacity of 2 dm3 supplied by a PGSTAT12 Autolab potentiostat (ECO Chemie). Samples were tested in described way by means of cyclic voltammetry by GPES program.

1. INTRODUCTION

Fossil fuels constitute the major part of energy sources consumed in the world today. These fuels cause environment pollution. On that account we must find new alternative source of energy. Hydrogen gas could be an alternative source of energy. One of the techniques of producing hydrogen is the electrolysis of water. However, this technique is quite expensive due to its high energy consumption. One of improvement could be alkaline solutions in water electrolysis. And second improvement could be better electrode: large active surface area, electrochemical stability, good electrical conductivity and low overpotential, low cost and ease of use. Several active electrodes have been developed for hydrogen evolution, and the performance of nickel based is the best in all. If we use nickel alloy, it will be cheaper this way.

Many methods are possible for coating layers. Chemical and galvanic deposition was used in this case. Chemical deposition was used for copper a nickel layers. Galvanic deposition vas used for NiZn alloy. NiZn alloys are very good for corrosion protective coatings. Electrical conductivity will be increase if we leach zinc component from NiZn alloy.

2. EXPERIMENTAL

The electrodes were cut from a metal plate about 3 cm length, 2 cm width and coated with polyester except a surface area of 2,2 cm2 for measurements.

Chemical coating of nickel was created in plating bath SLOTONIP 70 A for 30 minutes at temperature 92°C. SLOTOLOY 80 plating bath was used for creation galvanic deposit of NiZn alloys. Working temperature of planting bath was set-up to 30°C and current density

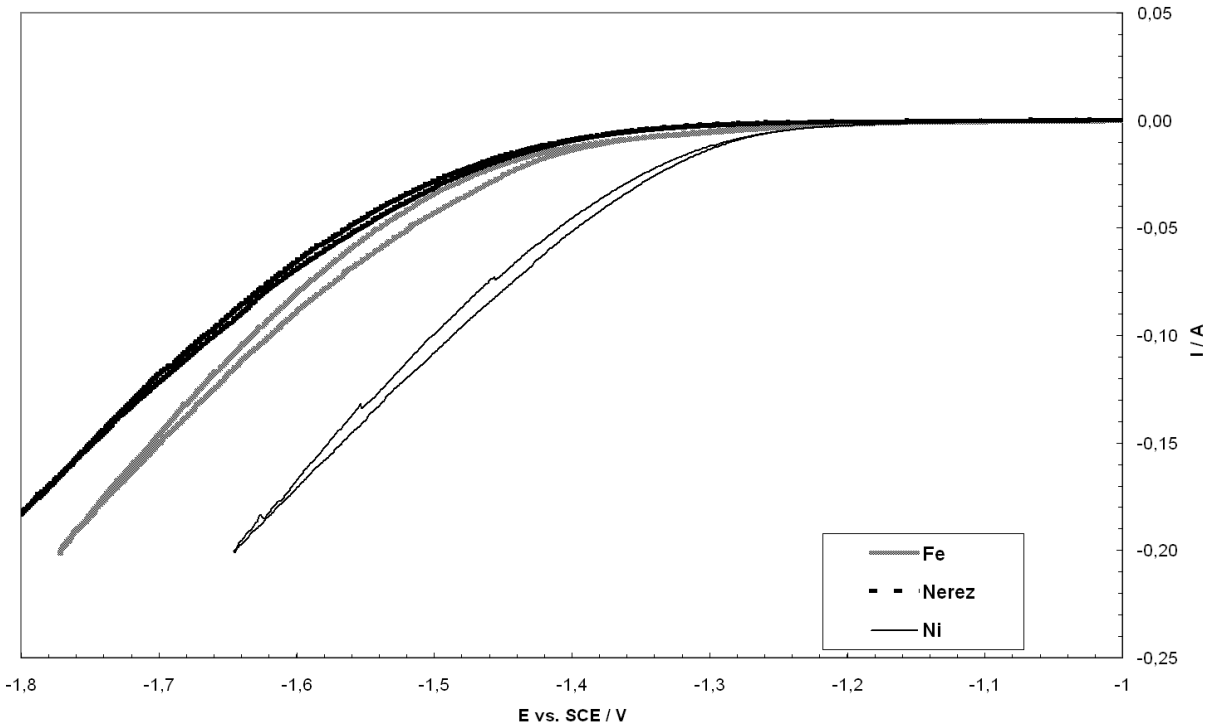
was set-up to 2 A /dm2 for electrodeposits. We can see operating conditions for every sample in table 1.

	chemical coating		galvanic coating NiZn		
Samples	**time [min.]**	**temperature [°C]**	**time [min.]**	**current density [A/dm2]**	**temperature [°C]**
Fe + Ni	30	92	-	-	-
Ni + NiZn	-	-	10	2	32
Fe + Ni + NiZn	30	92	10	2	32

Table 1 Operating conditions

Experiments were carried out in a three-electrode cell with a capacity of 2 dm3 supplied by a PGSTAT12 Autolab potentiostat (ECO Chemie). The samples were connected as work electrode, Saturated Calomel Electrode was connected as reference electrode and platinum electrode was connected as counter electrode. Samples were tested in described way by means of cyclic voltammetry by GPES program.

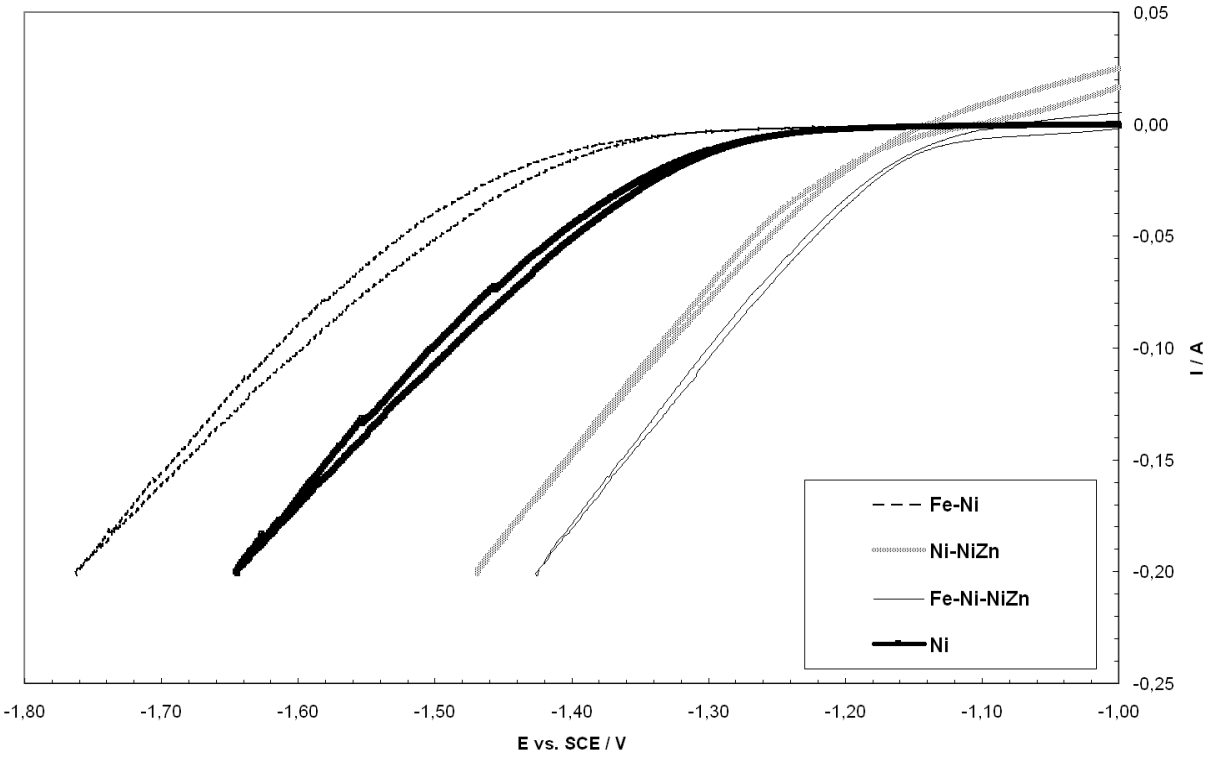
3. RESULTS AND DISCUSSION



Graph 1 Voltage-current curves

We can see a comparing of the three materials in graph 1. How we can see optimal material for hydrogen production at lowest consumption of energy is nickel. By this we are confirm, that Ni is very suitable for electrode system. We choose to create layers of nickel because pure nickel is very expensive. Modification of nickel-coated surface is possible to obtain major active surface. Nickel and alloys NiZn was created. Alloy NiZn

has high corrosive protective. We need it, because we use hydroxide as electrolyte in electrolyzer. Zinc component was leached from alloy by strong KOH.



Graph 2 Voltage-current curves

We can see curves of materials with layers in graph 2. Only sample Fe-Ni was worst then pure Ni. It was caused by more phosphorus component in deposit layer. It will be interesting to try galvanic depositing of nickel. The sample Fe-Ni-NiZn is the most acceptable. Difference potentials between pure nickel and Fe-Ni-NiZn is about 0,22 V.

4. CONCLUSION

Nickel is the best material for electrode on electrolysis waters, how we can see in graph 1. But nickel is very expensive so we must create nickel layers on cheaper base material. We can see in graph 2 that sample with 2 layers is better then others. NiZn alloy have good electrochemical stability and better electrical conductivity then others. This galvanic deposition will be used to create the best electrodes for electrolysis cell for hydrogen production. It is clear, that we can create suitable surface for electrodes. Hence, the reduction of energy by their use is possible.

ACKNOWLEDGEMENTS

This work was supported by the Ministry of Education, Youth and Sports, Czech Republic (project MSMT LC523).

REFERENCES

[1] KNOTEK, T.: Diplomová práce, Ústav elektrotechnologie VUT, Brno 2007
[2] G. Vatankhah, J. Lessard, G. Jerkiewitz: Electrochimica Acta 48 (2003)1613-1622
[3] Barek J., Opekar F., Štulík K. Elektroanalytická chemie KAROLINUM
[4] Regner A. Elektrochemické pochody v anorganickém průmyslu SNTL
[5] Ruml V. – Soukup M. Galvanické pokovování SNTL, PRAHA 1981. ISBN 04-614-81