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Physico-chemical properties of nickel-titanium dioxide coatings

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Results of the investigation of physico-chemical and structural properties of Ni-TiO_2 coatings, deposited by electrochemical process, are presented.

1. INTRODUCTION

Improvements in chemical processes bring many advantages in the area of the environment protection [1-5]. In electrochemical processes one can obtain compounds that are used in different processes of utilisation of water and sewage treatment or are halfproducts for creation of such compounds [2-7].

The reaction of hydrogen evolution on the electrodes Hg, Pb, Zn, Cd, Sn occurs with enough negative evolution overpotential. This favours especially cases, where high potential of electrolytic reduction reaction of organic and inorganic compounds is needed [3-5].

Realisation of many electrochemical processes on industrial scale depends still on suitable electrode material selection with required electrocatalytic properties [1-7].

The investigations of the influence of structural and physico-chemical properties of nickel-titanium dioxide coating, deposited on SPG-1 steel, using the electrochemical process are presented in this work.

2. RESULTS AND DISCUSSION

The parameters used during the electrolytic bath of the "Metallchemie" firm are presented at Tab. 1. Basing on the mass gain of samples the current efficiency of the electrochemical process has been counted and is presented in the Tab. 1, too.

Table 1
Investigated parameters and current efficiency of Ni-TiO_2 coatings

Titanium dioxide concentration in the electrolytic bath, [g/0,8dm^3]	Temperature, [K]	ph in the bath, [-]	cathode current density, [A/m^2]	Mass gain, [%]
1,0	308 ÷ 318	3,8 ÷ 4,2	300	90
2,0				88
3,0				72
4,0				70

Physico-chemical investigations of Ni-TiO_2 coatings, deposited using the electrochemical process on SPG-1 steel (PN88/N69: C_{max} 0,10%, Si_{max} 0,03%, Ni_{max} ,03%, Mn 0,35 ÷ 0,65%, Cr 0,2%, S+P $_{(max)}$ 0,03%), done in this paper concern such electrochemical properties, as:

- hydrogen evolution overpotenctial,
- elaboration the corrosion diagrams,
- active area surface,

and the structural analysis of this coatings.

Using polarisation curves, that the define function E=f(logJ), parameters characterisation cathode material were found constants in the Tafel equation ("a" and "b") and zero potential. The polarisation curve was figured out using the potentiostatic method. The tests were conducted in the electrolytic cell, in the basic solution, at 25^0C in the relation to the SCE (saturated calomel electrode).

Coefficients "a" and "b" values from the Tafel equation (1)

$$\eta = a + b \log j \tag{1}$$

and simultaneously of hydrogen evolution overpotential value on investigated of nickel-titanium dioxide coating, are presented in Tab. 2 and Fig. 1.

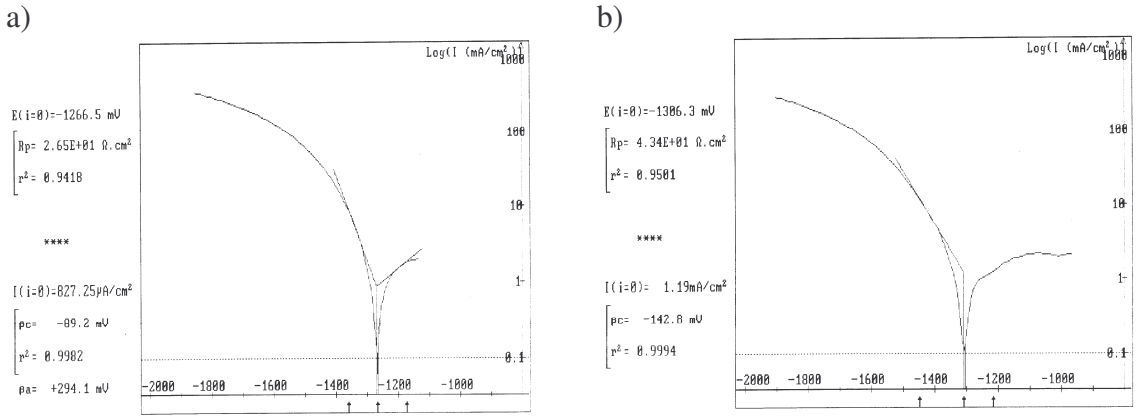


Fig. 1.The relation between current density of hydrogen evolving and the electrode potential Ni-TiO_2coatings: a) for 1g TiO_2/0,8dm^3, b) for 4g TiO_2/0,8dm^3

Table 2
Coefficients *a* and *b* in the Tafel equation (1) in the 1M NaOH solution

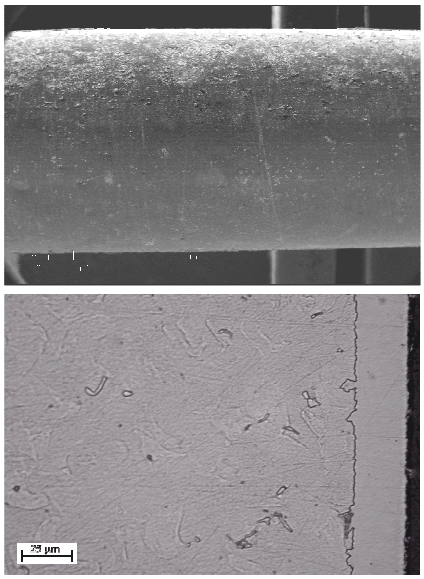
TiO_2 concentration, [g/0,8dm^3]	-a, [mV]	-b, [mV]
1,0	203	89
2,0	235	97
3,0	224	92
4,0	243	143

The corrosion curves and active area surface investigations were conducted in the electrolytic cell and tests were done in basic solution at 25^0C in relation to the SCE. Tabl. 3 presents the corrosion rates and grade of the active area surface development.

Table 3
Corrosion rates and grade of the active area surface development in tested solution

TiO_2 concentration, [g/0,8dm^3]	Corrosion rates, [mm/year]	Grade of the active area surface development, [-]
1,0	0,014	7,1
2,0	0,042	5,8
3,0	0,045	5,9
4,0	0,010	3,2

As the results of investigations made using the scanning microscope it was found that the morphology of the surface of nickel-titanium dioxide coatings is both homogeneous and no homogeneous. It depends on the quantity of titanium dioxide added to the electrolytic bath (Fig. 2 and Fig. 3.).



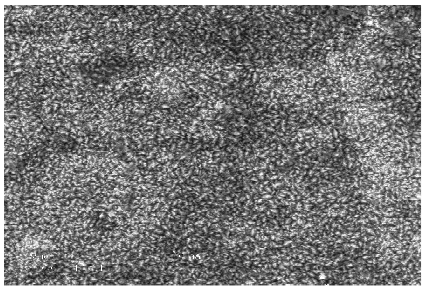
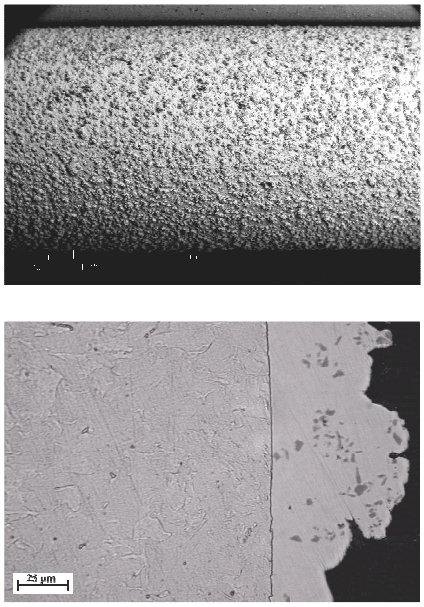


Fig. 2. Structure of nickel-titanium dioxide for the 1g TiO_2/0,8dm^3 on the bath



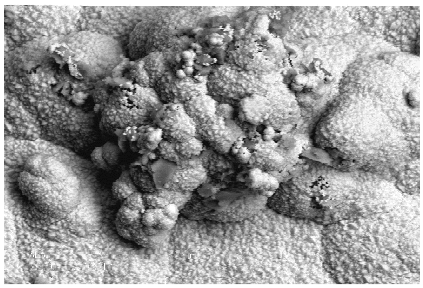


Fig. 3. Structure of nickel-titanium dioxide for the 4g TiO_2/0,8dm^3 on the bath

3. CONCLUSION

The oxide electrodes deposited by electrolytic process influence analysed physico-chemical properties of the proposed electrodes.

The proposed oxide electrodes characterise by the low hydrogen evolving overpotential.

The corrosion rate is not too high. This coatings increases corrosion resistance of the base metal.

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