Corrosion Protection of Nickel Equipment in Chloride-Fluoroniobate Melts

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Owing to its good corrosion resistance, nickel is often applied as material for reactors operated with salt melts, including a use in sodium-thermal production of tantalum and niobium powders. Nickel concentration in powders is strictly regulated by the technical specifications. In this connection, it seems interesting to study the possibility of creating of diffusion barrier coatings on a nickel surface to reduce the rate of equipment corrosion.

The aim of this study was to investigate the possibility of obtaining of diffusion barrier coatings on nickel surface in chloride-fluoroniobate melts used at sodium-thermal production of niobium powders and investigating of the coating characteristics.

For the experiments NaCl-K_2NbF_7 melts were selected. The studies were carried out in helium atmosphere at 750°C. During the experiment we checked the specimen weight prior and following the test. Phase composition was determined by X-ray diffraction with CuK_α- radiation. The coating microstructure was investigated on polished cross sections under "Neophot" optical microscope. Roughness was determined by profilograph-profilometer. The nickel substrate/coating interface was analyzed with a CAMEBAX electron probe X-ray microanalyzer. Microhardness (H_μ) was measured by PMT-3 tester.

In paper [1] was shown that the generation rate of surface diffusion coating in chloride-fluorotantalate melts is considerably increased at introduction to the melt of tantalum powder. In view of this fact at the research of obtaining possibility of diffusion barrier coatings on nickel in chloride-fluoroniobate melts in the explored melt is introduced the niobium powder. As it is seen from Fig. 1 depending on ratio of NaCl/K_2NbF_7 the corrosion of nickel specimen stops at introduction to the melt 3-4 wt. % of Nb-powder (to an amount of potassium fluoroniobate introduced into a melt) and weight of specimen is increased. Thus the formation of coatings consisting of Ni-Nb intermetallic compounds takes place at nickel surface (Fig. 2). The typical interface Ni-Nb is given in Fig. 3. The research of the coating microstructure by optical microscope proves to be true by outcomes of definition of roughness by profilograph-profilometer. As the coating thickness is increased, the roughness of sample rises rapidly. Besides the formation and growth of separate dendrites is observed. The H_μ value of the Ni-Nb coatings is 8500±500 MPa and does not depend on the coating thickness. The coating microhardness values correlate with results of electron probe X-ray analysis (Fig. 3).

Thus, our investigations demonstrate the possibility of corrosion protection of nickel in chloride-fluoroniobate melts by plotting on a nickel surface of diffusion coatings consisting of Ni_3Nb and NiNb intermetallic compounds.

[1] V.N. Kolosov, E.S. Matychenko, V.M. Orlov and A.T. Belyaevsky, *Russian J. Appl. Chemistry*, V. 74, No 9, p. 1452-1456 (2001).

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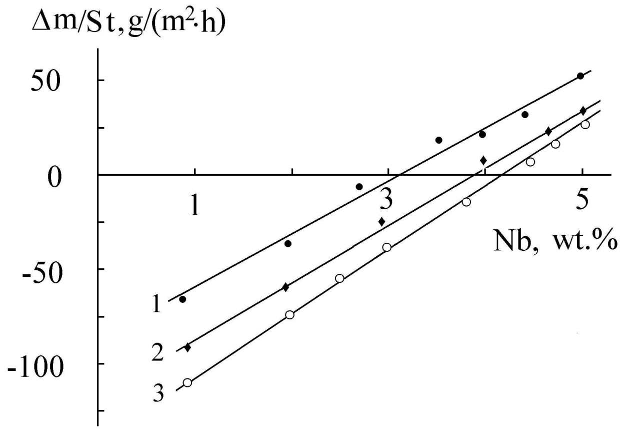

Fig. 1. The specific change of the nickel specimen weight as function of the niobium powder contents in the NaCl - K_2NbF_7 melts. Concentration of K_2NbF_7 salt in melt (mole %): 1 – 10, 2 – 20, 3 – 30.

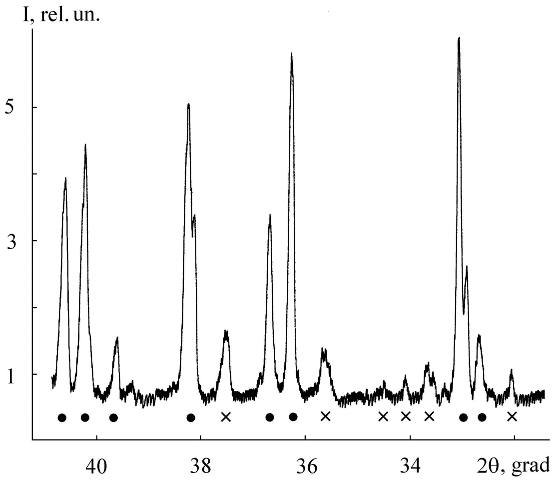

Fig. 2. XRD scan of Ni-Nb diffusion coating on nickel substrate:•- Ni_3Nb compound, ×- NiNb compound.

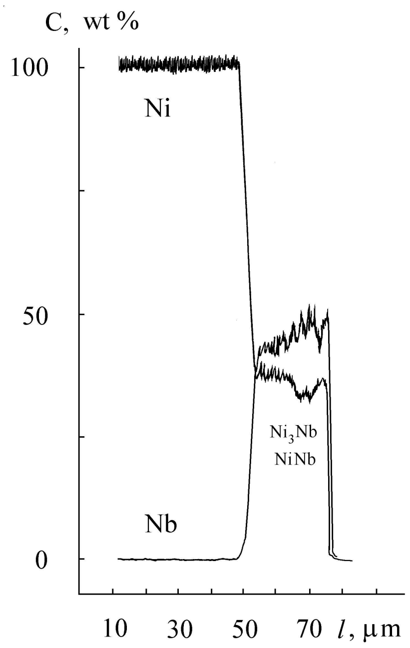

Fig. 3. Ni and Nb compositional profiles across the Ni/Nb interface of diffusion coating on nickel substrate.