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CORROSION AND ELECTROCHEMICAL PROPERTIES OF NANOSCALE COMPOSITE LAYERS OBTAINED BY LASER SINTERING

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Laser sintering of powders is a prospective technique for formation of surface composite layers consisting of nanoscale structures. In this work sintering of nanoscale powders has been performed using the Yb fiber-optic laser in the impulse mode. The prepared powder compositions with a typical grain size of less than 40 nm was spread on a steel substrate and then processed by laser.

Different powder compositions containing Fe–0,5 wt.% C, Fe–3,2 wt.% Ni and Fe–10 wt.% Ni were studied. The applied technique allows varying of the depth and chemical composition of the sintering layer. Formation of nanoscale structural elements of the surface is due to extra high cooling rates (up to 10^7 K/s) and large gradients of temperature (up to 10^7 K/m). Under processing in the inert gas atmosphere microstructural elements do not generally contain oxides although sintering in vacuum leads to generation of different metal oxides on the surface due to residual oxygen. After laser processing the sample's surface was examined using TEM and SEM, X-ray and EDAX analysis. The X-ray photoelectron spectra analysis (XPES) as a function of distance from the surface provided data on chemical composition of the sintering layer in a distance of 40 nm. In sintering of Fe-C powders surface compounds containing carbide and oxides phases are formed depending on the mode of laser annealing. In the Fe–Ni samples the surface includes nanoscale iron particles in discontinuous nickel shells.

Corrosion and electrochemical study of the processed composites revealed that all coatings have enhanced corrosion resistance in neutral and alkaline media which is due to easier passivation of the surface than in the case of unprocessed samples. More importantly, some annealing modes provide new coatings which are initially passive.

It has been proved that composite Fe–Ni sintered layers have significantly higher electrocatalytic activity in the reaction of hydrogen generation by electrolysis of alkaline solutions than pure Fe and Ni samples. This is a prospective application for hydrogen-base engineering technologies.