CHANGES IN THE DEFECT STRUCTURE OF TITANIUM DURING HYDROGENATION

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The hydrogenated samples of technical titanium have been investigated using the EPA method and the measurements of thermal electromotive force for these samples saturated with a different amount of hydrogen. The structure of the hydrogenated samples has been studied by means of the X-ray diffraction method. The different methods of measurements have shown that the hydrogenated titanium structure starts changing at the same time, depending on the amount of added hydrogen. The intensity of the annihilation process increases with the increase in the hydrogen concentration in α-titanium up to the values of 4% Wt and does not change up to the values of 5% Wt (α + δ) - titanium. At the same time, the value of thermal electromotive force decreases in this range of values. The annihilation intensity is stabilized for the values of 5% Wt, and the value of the thermal electromotive force is increased. The inflection point for thermal electromotive force versus the hydrogen concentration curve corresponds to the formation of δ - hydrides. The increase in the positron lifetime starts in the concentration range of 6-8% and moves to the stable level up to the concentrations of 21-22%. In this range, there is a transition from the (α + β) to the (α + δ) phase. The lifetime of positrons and the number of defects are increased, the value of thermal electromotive force is reduced (up to the concentration of 24%), then there is a stabilization mode for all these parameters up to the values 32% Wt.

The samples of technical grade titanium 30 × 30 × 1 mm in linear size were used for the study. The samples were saturated with gaseous hydrogen at a high pressure and temperature according to the Sieverts' method by using the automated complex «Gas Reaction Controller» (Advanced Materials Corporation). The hydrogen concentration was determined during the process of hydrogenation by using a gravimetric method. Spectra of PL in the samples were collected using the spectrometer described in detail in [1]. Time resolution of this spectrometer was 240 ps. Three spectra of 5 * 106 events were collected for every sample. They were mathematically fitted by the sum of 1 gaussian and several exponential functions according to the two-state trapping model by LT10 software. After background and source contribution subtraction, the decomposition of the spectra was carried out by two exponential components. Each component can be characterized by the positron lifetime (τ) and intensity (I) values.

The results have shown that hydrogen in titanium influences the value of thermal electromotive force. The distinctive inflection point found for thermal electromotive force versus the hydrogen concentration allows the concentration of hydrogen in titanium to be quickly determined, when there is a rearrangement of titanium alloy structure. These results are in good agreement with the results of the EPA analysis. The transition from one structure to another one is shown to be observed even at concentrations of hydrogen in the titanium of about 0.5% by weight. By comparing the structural phase state of the titanium alloy, such as Ti H_2 : 4.04 wt% Ti H: 2.02 wt% Ti $H_{0.5}$: 1.01 wt%, there is a possibility to control the combination of titanium with hydrogen according to the measurements of thermal electromotive force using the thermal electromotive force dependence versus the concentration of hydrogen in titanium.