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STRUCTURE AND ABSORPTION PROPERTIES OF NANOCRYSTALLINE VN_X FILMS WITH NICKEL PROTECTIVE COATINGS

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This paper highlights the study of structural and absorptive characteristics of nanocrystalline porous VN_x films produced by ion beam-assisted deposition technology (IBAD method). VN_x films of 1.5 μm thickness were deposited on sapphire substrates. In order to investigate the effect of oxygen molecules on the absorption properties, some samples were coated with a 5 nm nickel protective layer. The initial structure of these films and their structure after hydrogen release were investigated by means of transmission JEM 100CX and scanning JSM 7001F electron microscopes. Thermodynamic characteristics of the films were studied using a mass spectrometer. The total amount of absorbed hydrogen was determined by measuring the pressure in a closed chamber at heating the film saturated with hydrogen.

It was found that VN_x films consist of 50-100 nm nano-particles separated by porous boundaries of 4-8 nm thick. In turn, nano-particles consist of 10-15 nm nano-grains. Such structure is typical for films both with and without protective coating. The difference in structure appears only after 10 "hydrogen absorption/desorption" cycles. In films with a protective nickel layer, the original structure is preserved after absorption and desorption of hydrogen. In the films without a protective layer, the partial porosity disappearance and formation of dense crystal structure with the 100-300 nm grains take place.

It was revealed that there are two peaks (at 150°C and 420°C) in the spectra of thermal desorption of hydrogen from films without the protective nickel layer. Moreover, with increasing hydrogen pressure, at which the films were saturated, the fraction of the low-temperature peak increased. At the same time, there is only one maximum at 250°C in the films with protective layer. The total amount of hydrogen absorbed by VN_x films increases with pressure increasing and reaches 3.5 wt. %. No correlations between the gravimetric capacity of the films and the presence of protective layer were detected.