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Thermal Stability of Hafnium Diboride Films, Obtained on Substrates of Steel 12X18H9T and Cutting Plate T15K6

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Investigation results of the influence of high-temperature annealing in the air environment on the phase structure and structure of hafnium diboride films, received on substrates from steel 12X18H9T and cutting plate T15K6 are presented. It is shown that in the course of annealing on a surface of HfB_2 film the oxide layer of HfO_2, with monoclinic structure is formed. Thus, annealing temperature increase from 600 to 1000 °C leads to increase in thickness of an oxide layer from 100 to 600 nanometers and to formation of a multilayered covering of HfB_2 - HfO_2. On substrates of steel 12X18H9T the coating is destructed at the temperature higher on 800 °C than for T15K6.

Keywords: Structure, Thermal stability, Diboride, Oxide, Annealing, Temperature.

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Sheetings on the basis of nitrides and carbides of transitional metals, are now inexpensive way of increase in productivity of the cutting tool. Borides of a hafnium, along with nitrides and carbides possess the raised physics-mechanical characteristics and have rather high temperature of melting 3250 °C. The most studied is thermal stability in vacuum thin nitride [1-5], and to a lesser extent carbide films [6-7], thus, as show researches, thermodynamic stability of nitride coverings in vacuum is limited to temperatures 1000-1100 °C. Thermal stability of nanostructures on a basis borides and boronitrides transitional metals is investigated in very limited quantity, generally on a basis diboride the titan [8-10]. Researches of stability of borides films in the air environment at high temperatures, except for work [12], practically it was not carried out.

Therefore, research of thermal stability of films diboride a hafnium in the course of high-temperature annealing on air on substrates from steel 12X18H9T and hard-alloy plate T15K6 was the purpose of this work.
As studied coverings samples of films diboride a hafnium, having columnar structure and a structure of growth by the plane (00.1) received on substrates from stainless steel 12X18H9T and plate T15K6, by the technique which has been earlier described in works [13,14] were used.

Thus, studied films had the best physics-mechanical characteristics: hardness $H = 44{,}5$ GPa, the module of elasticity $E = 396$ GPa also were thickness of 1,3-1,5 microns. Annealing were carried out in the vacuum SNVE-1.3.1/16 furnace and at $T = 600$, 700, 800, 1000 °C.

At covering heat treatment at 700 °C within 1 hour (see Fig. 1), there is an appreciable decrease in intensity of peaks (00.1) and (00.2) phases HfB_2, and thus, in turn observe appreciable increase in intensity of peaks (-111); (111); (-220); (221), (020), corresponding to monoclinic structure of the phase HfO_2 ("and" = 5,12A «, b» = 5,18A «, with» = 5,25A).

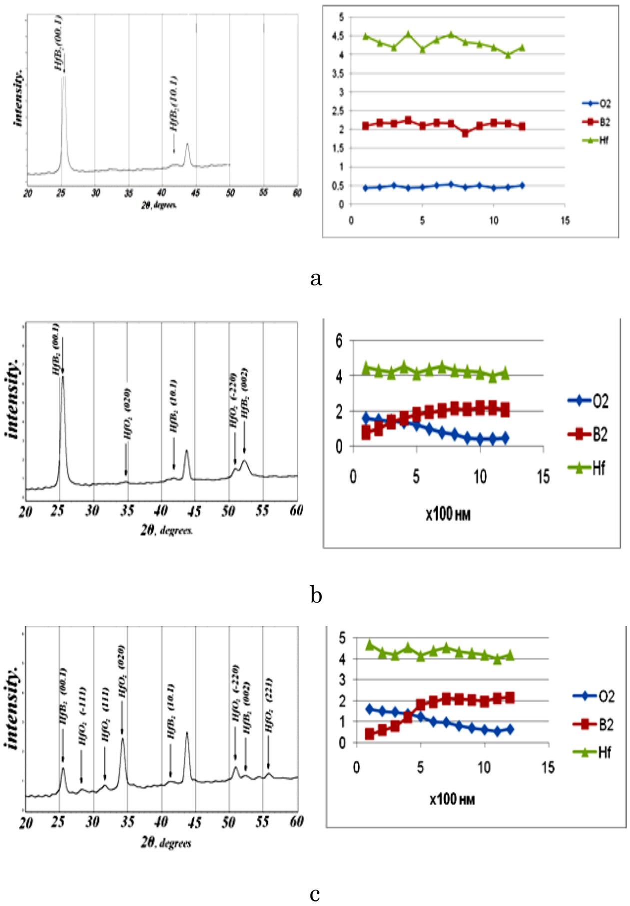

Fig. 1 – Difractogram and data of SIMS (Secondary to ions of masses spectroscopy) of studied coverings on substrates from steel 12X18H9T: initial covering, columnar structure with a texture growth (00.1) (a), annealing 600°C at 1 hour (b), annealing of 700°C at 1 hour (c)

At increase in temperature 800°C and 1000°C, within 1 hour, the picture cardinally doesn't differ from re-

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ceived, it is possible unless to note increase in thickness of an oxide layer to 600 nm.

The analysis of concentration profiles of distribution of oxygen and pine forest on depth of a film diboride of hafnium shows that on a surface of a film there is an essential decrease in concentration on pine forest and respectively increase on oxygen. Proceeding from the rentgeno-structural and SIMS-research, we see that on a surface of a film of HfB_2 there is a formation of a thin oksidny layer of HfO_2 to 300 nm.

At research of thermal stability of a film covering on a substrate from T15K6 (fig. 2) to temperature 800°C in the course of annealing of a film of HfB_2 on air, occurs formation of an oxide layer of HfO_2, is similar as well as on substrates from stainless steel 12X18H9T. At temperature increase above 800°C there is a destruction of a film covering that in our opinion, is connected with arising macrostress.

Thus, in the course of annealing the film covering receives an oxide layer on a film surface, at various temperatures the thickness of this layer varies from 200 to 500-600 nm.

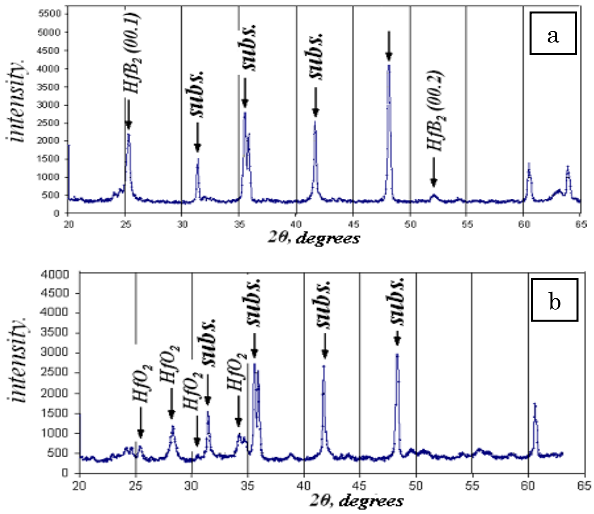

Fig. 2 – Difractogram of HfB_2 system – substrate T15K6 without annealing (a), annealing at 600°C within at 1 hour (b)

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