Niobium Boronizing: influence of the treatment temperature and time

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Developments with Nb alloys have been performed for high-temperature application, involving the challenge to enhance the alloys oxidation and wear performance. Currently the Ni superalloys had become the endpoint of high-temperature turbine applications, refractory metals, such Nb, emerge as possible substitutes if surface performance is enhanced. This can be addressed with a barrier protection of Nb exhibiting high-temperature oxidation and mechanical resistance [1]. This study is part of an ongoing investigation on the processing and characterization of Nb borides coatings. This initial set of results allows to assess the kinetics of boronizing pure Nb using the special procedure of double pack cementation. Boronizing was carried out for 1 and 4 h at 950 and 1100 °C, respectively. Ekabor commercial pack mixture, with nominal chemical composition of 90 % SiC, 5 % B_4C, and 5 % KBF_4, was used without and with 10 wt % Si additions. SEM, EDS, and XRD analyses and microhardness tests were used to characterize the treated samples. A continuous higher hardness layer of $NbB_{2,}$ with 2800 $HV_{0.05}$, was identified at the surface of Nb, originally presenting a hardness of 110 $HV_{0.05,}$ results supported by data from literature [2]. A maximum layer thickness between 50 and 55 µm was measured after 4 h at 1100 °C whereas after 1 h at 950 °C no visible layer was identified with applied characterization techniques. Adding 10 wt % Si to the pack mixture impacted the kinetics of the diffusion process, as shown by the increase on the layer thickness, ranging from 90 to 100 µm, after processing for 1 h at 1100 °C. Besides the increase in treated layer thickness Si also induced cracks and a brittle aspect of the surface.

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References:

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