POLITECHNIKA ŚLĄSKA W GLIWICACH

Wydział Mechaniczny Technologiczny

mgr inż. Radosław Szklarek

PRACA DOKTORSKA

Badanie struktury i własności krzemkowych warstw wytworzonych na podłożach molibdenowych i niobowych

Promotor:
dr hab. inż. Tomasz Tański prof. PŚ

Promotor pomocniczy:
dr inż. Marcin Staszuk

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Abstract

The results presented in this paper are focused on structural analysis and properties of silicide diffusion layer created on the molybdenum and niobium surface using high temperature Pack Cementation process. Concerning the comparison process the three types of thickness of silicide layer were created on molybdenum and niobium specimens surfaces as 50, 70 and 90 of microns. Measuring the hardness of silicide layers results similar value which is 1180HV0,05 for niobium silicides and 1230HV0,05 for molybdenum silicides. The silicide structure has characteristic columnar shape with thin transition zone which separate silicide diffusion layer and metallic substrate of Mo or Nb. The thickness of transition zone was calculated in the range of 500÷1250nm, where maximum value is typical for niobium silicides. In comparison to the niobium silicides the structure of molybdenum silicide layer contains more recrystalized grains which propably were created because of long Pack Cementation time. As a result of cooling which is needed after pack cementation process some perpendicular cracks were observed on the all silicides surfaces. The width of these cracks are not the same and were calculated in the range of 180÷2260nm where the widest cracks were characteristic for molybdenum silicide layers. Additionally some longitudinal cracks which were identified in niobium silicide layers only and were observed in 10μm from metallic substrates. The cracks generation process phenomena is a result of thermal stress which are generated inside the silicides layer and metallic substrate during cooling process. The main influence for this process has the difference in thermal linear expansion factor between silicides layer and metallic substrate and also because of different thermal state of both materials. The presence of perpendicular cracks has no negative influence for high temperature oxidation resistance in temperature above 1400°C because of silicides surface passivation process occures in oxygen atmosphere where stable liquid SiO_2 coating with thickness in range of 300÷1500nm is created on whole silicides surface, as well as inside the silicide layer cracks. The high temperature oxidation test was performed using modified HVOF spray coating equipment which simulated rocket combustion chamber engine in close to normal working conditions. In this work using various methods of analysis and research process the silicides diffusion layers which were created using Pack Cementation process on molybdenum and niobium substrates are effective protection against high temperature oxidation.