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ROLE IN THE FORMATION SUBLAYER THERMAL BARRIER COATING

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Surface flame tube combustor and nozzle apparatus turbine engines operating in severe conditions (high temperatures and the presence of hot gases of the abrasive particles in the fuel combustion products) so require for their manufacturing materials with operating temperature up to 1300 °C [1-3].

Modern heat resisting steel is not capable of withstanding such temperatures. Therefore, the question was decided by the use of heat-resistant alloys such as ЭИ648, ЭИ868, ЖС-6У and ВХ-4Л with high-temperature protective coating

Studies in plazmotehnology laboratory showed that high-temperature protective coatings can be plasma-based coating oxide (ZrO2, Al2O3, Cr2 O3).

Improving the strength of ceramics to metal adhesion is possible by applying the intermediate layer (underlayer). The most common material is nickel sublayer aluminum alloy brand ПН70Ю30. However, for coatings that operate at temperatures up to 1300 °C, this underlayer is unsuitable because it begins to oxidize (1200 °C) to form a complex oxide NiAl2O4. Formation of the oxide coatings is accompanied by change of the volume, and this leads to peeling of the heat-resistant coating based on ZrO2 + Ni. In addition, nickel-aluminum alloy is very fragile NiAl intermetallic compound, which leads to cracks in the alternating load.

A new sub-layer of the alloy powder SoSrAlY brand ПКХ27Ю7С3И production NPP "Eltehmash."

For the application of the proposed solution as the underlayer material determined by physic-mechanical properties of the cobalt alloy coatings SoSrAlY and compared with the currently used nickel base alloy PN70YU30 mark.

Primarily determined by the heat resistance and thermal coatings, and then their mechanical properties.

Heat resistance was evaluated in accordance with GOST 6130-71 as the ratio of sample to total weight gain of sample area in Δg'τ mg/cm2 thermo cycles depending on tests where the thermal cycle of 5 hours heating the sample at 1000 °C. All samples were tested for three cycles. Test results are shown in Table. 1.

Thermal stability was evaluated by the number of heating-cooling cycles until the first cracks. Heat produced oxyfuel burner (propane-butane) to a temperature of 1800 °C, and then they were cooled by air flow to a temperature of 600 °C. Test results on heat stability are shown in Table .2.

Analysis of the data table (Table 1) shows that increasing the heating time with samples 5 to 15 hours leads to an increase in oxidation resistance of coatings.

When comparing sublayer PN70YU30 and heat resistance SoSrAlY, SoSrAlY is up to 25-43% higher. This relation is valid for all base materials EI648, VC-4L, EI868 and ZS-6U.

Table 1

Results of the study of heat resistance of the 1st layer (sub-layer) in the formation of a protective two-layer coating for turbine engine combustor

№	The main material and the sample number	material 1st layer / Aea spraying cm2	The temperature of the medium test, ° C	The test, hour	Prywes specimens mg	Heat resistance, Δg'τ, mg/cm2
1	ЭП 648 №3	CoCrAlY	1000±2	5	111,20	3,57
				5	5,85	0,19
		23,55		5	4,35	0,14
2	ЭП 648 №4	ПН70Ю30	1000±2	5	182,15	5,54
				5	6,90	0,29
		32,8		5	4,80	0,20
3	ВХ-4Л №5	CoCrAlY	1000±2	5	129,85	3,44
				5	7,60	0,20
		37,7		5	5,10	0,13
4	ВХ-4Л №9	ПН70Ю30	1000±2	5	187,90	5,10
				5	13,60	0,50
		36,7		5	6,30	0,23
5	ЖС-6У №7	CoCrAlY	1000±2	5	133,00	3,95
				5	7,30	0,21
		33,6		5	6,00	0,18
6	ЖС-6У №8	ПН70Ю30	1000±2	5	203,00	6,04
				5	26,00	0,68
		32,8		5	6,30	0,24
7	ЭИ 868 №6	CoCrAlY	1000±2	5	132,85	4,05
				5	4,30	0,14
		32,8		5	4,00	0,12
8	ЭИ 868 №10	ПН70Ю30	1000±2	5	200,20	5,58
				5	7,80	0,28
		35,87		5	5,60	0,20

In materials research base sublayer most heat-resistant alloys are VC-4L, EI868 with sublayers of cobalt alloy SoSrAlY where Δg'τ = 0,13 mg/cm2 and 0.12 mg/cm2, respectively.

Studies on the thermal stability showed high efficiency of material based on SoSrAlY. Coatings of SoSrAlY showed no signs of delamination after 80 termosmen, at the same time of NiAl underlayer began to crack after 40 termosmen. The base material of a noticeable effect on thermal stability has not. Showed the highest heat resistance coating SoSrAlY based VC-4L and EI 868 (> 82 number of heating cycles) coating on the basis of NiAl EI 868 (<40 number of heating cycles).

Table 2

Heat resistance of coatings and NiAl alloys SoSrAlY mode heating-cooling 1800 ° C - 600 ° C

№	The main material and the sample number		Material sublayer δ = 0,2 mm	Test cycle, ° C	Number termosmen to cracking
1	ЭП648	№3	CoCrAlY	1800 – 600	>82
		№4	ПН70Ю30	1800 - 600	< 40
2	ВХ-4Л	№5	CoCrAlY	1800 - 600	>82
		№9	ПН70Ю30	1800 - 600	< 40
3	ЖС-6У	№7	CoCrAlY	1800 - 600	>82
		№8	ПН70Ю30	1800 - 600	< 40
4	ЭИ868	№6	CoCrAlY	1800 - 600	>82
		№10	ПН70Ю30	1800 - 600	< 40

CONCLUSIONS

1.For increase resistance cermet and metal-based spinel underlayer is required.

2.When the formation of heat-resistant coating of cermet and spinels in their operation up to 1800 ° C is recommended sublayer SoSrAlY for any base material (heat-resistant steel).

3. Thermal stability of the coating underlayers highest (more than 80 termosmen) SoSrAlY the alloy.

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