INVESTIGATION OF HEAT-RESISTANT MATHERIALS IN SUPERSONIC HIGH-TEMPERATURE FLOW

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The aim of the investigation is focused on the experimental research of thermal stability of heat-resistant alloy and composite material samples exposed to prolonged high temperature flow (Mach number M = 2.2 stagnation temperature T_0 up to 2400 K), as well as on determination of heating features during durability tests of combustion chamber model. The investigation was performed on the ITAM SB RAS stand of supersonic combustion.

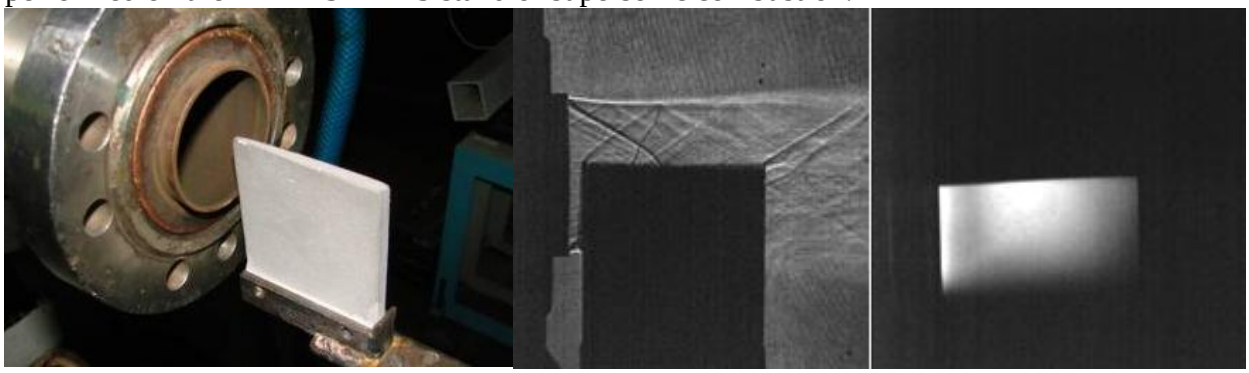

Fig 1. A sample mounted at the nozzle exit; schlieren registration of the sample; heated sample in the high-temperature flow.

Conducted experiments show that the most common heat-resistant materials can withstand limited time in high-temperature supersonic flow without active cooling.

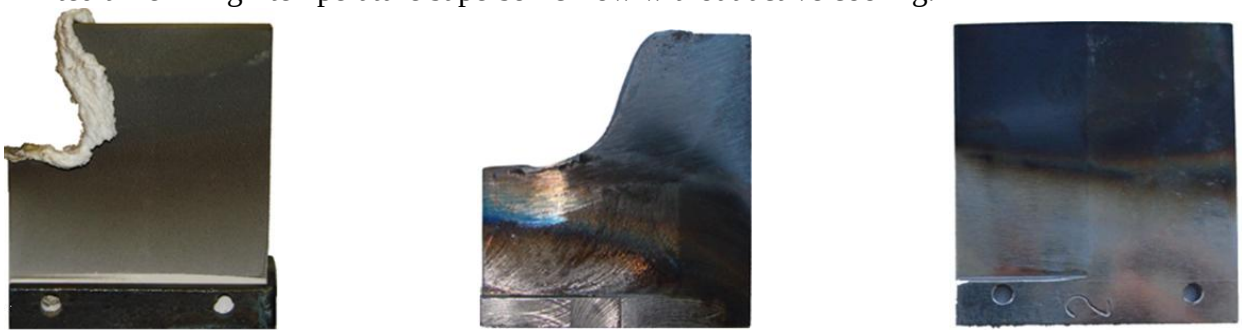

Fig 2. Samples of various materials exposed to high-temperature supersonic flow.

On the basis of completed tests, C/SiC material was considered as the most suitable to create a canal that simulates a combustion chamber of high-speed aircraft. This canal was tested, by number of prolonged (up to 110 seconds) injections of high-temperature supersonic jet (Mach number M = 2.2 stagnation temperature T_0 up to 2200 K).

Fig 3. Durability tests of the combustion chamber made of C/SiC.

Significant temperature distribution inhomogeneity of canal walls (both in the longitudinal and transverse directions) was revealed during tests. Thus, the design of combustion chamber active cooling systems of high speed aircrafts should take into account peculiarities of the distribution of temperature and heat flow arising during work. This will optimize cooling process, and reduce the weight of the cooling rig.

Conclusion: Most common heat-resistant materials can withstand limited time in high-temperature flow in the absence of active cooling. Both nonstationarity of gas dynamic structure in the flow path and the inhomogeneity of distribution of heat flux in the wall (in the longitudinal and transverse directions) should be taken into account to create effective active cooling protection.