The Development of The Prototype of the System for Monitoring a Stress-Strain State of a Outlet Guide Vane With the Help of a Fiber Optical Sensors

A.N. Anoshkin, G.S. Shipunov, A.A. Voronkov, K.A. Pelenev, E.N. Shustova and A.A. Tikhonova

Perm National Research Polytechnic University; PNRPU 29 Komsomolsky prospekt, Perm, Perm krai, Russia, 614990 e-mail: rector@pstu.ru, web page: http://www.pstu.ru

ABSTRACT

Currently, polymer composite materials (PCM) are beginning to be widely used in aircraft propulsion systems. Experience in the use of such materials in such structures exposed to complex loading for a long period of time is small. Therefore, of great interest is the development of systems for monitoring the state of such parts for use both during bench and flight tests, and during the operation of propulsion systems.

Currently, the most common monitoring systems are based on fiber-optic sensors. Fiber-optic sensors (FOS) are one of the key elements of the monitoring system and allow you to measure temperature and strain. At the same time, FOSs are able to withstand deformations comparable to deformations of the composite, they are immune to electrical interference, are highly sensitive and can be incorporated into the structure of a composite material to control structures during the entire life cycle. In this paper, we use Bragg gratings FOS.

The work presents the results of monitoring the stress-strain state of a carbon-fiber outlet guide vane (OGV) using a FOS system. The paper considered the options for the placement of FOS on the surface of the object, and embedded in the structure of the material. At the same time, a technological process was introduced for inserting FOS into a structure with standard autoclave manufacturing technology with a processing temperature. The sensor placement area in the composite structure was chosen to control deformations in the area of possible fracture and along the central part of the blade feather to determine the averaged stress-strain state. During the tests, the sensitivity and features of the sensors in the complex stress state of the structure were evaluated.

The test results were compared with the results of mathematical modeling of the mechanical behavior of the OGV during laboratory tests with different loading options. Using a mathematical model, stress and strain fields in the OGV structure were calculated. Areas of potential damage were assessed using strength criteria. This allowed to determine the placement of fiber-optic sensors. Numerical simulation of this problem was carried out by the finite element method (FEM) in the ANSYS Workbench software.

According to the results of research, a prototype of a system for monitoring the stress-strain state of composite structures using fiber-optic sensors under quasistatic loads was proposed.

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