Fiber optical detector for foreign object damage of composite turbine blade

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Composite fan and stator blades of the turbofan engines are subjected to damage caused by high-speed foreign objects (hail, rocks, debris). So it is important to detect such events and their consequences. Especially when initial damage leads to progressive damage of an element due to cyclic and static load. Traditional gages such as acoustic emission sensors are hard to place on the blade avoiding aerodynamic or structural strength problems. Fiber optic Bragg sensors can be easily integrated into the blade, but have limited bandwidth to detect short events. We propose interferometer-based distributed fiber-optic sensor where one leg of the interferometer is the sensor fiber evenly distributed inside the blade. Acoustic waves caused by impact or acoustic emisson of fiber breaking cause deformation of the fiber and lead to change of its optical length. Bandwith of the sensor is mainly limited by the diameter of the optical fiber and its shielding like for manganine gage. The proposed sensor's advantages are its high bandwidth and ability to detect both the impact event and consequent damage evolution. Disadvantages are lack of location ability and complexity of the signal because acoustic wave passes optical fiber multiple times on its way. The work was carried out as part of a major scientific project funded by the Ministry of Science and Higher Education of the Russian Federation (Agreement No. 075-15-2024-535 dated 23 April 2024).