New multilayer thin-film sensors enable fast, efficient monitoring of aircraft defects

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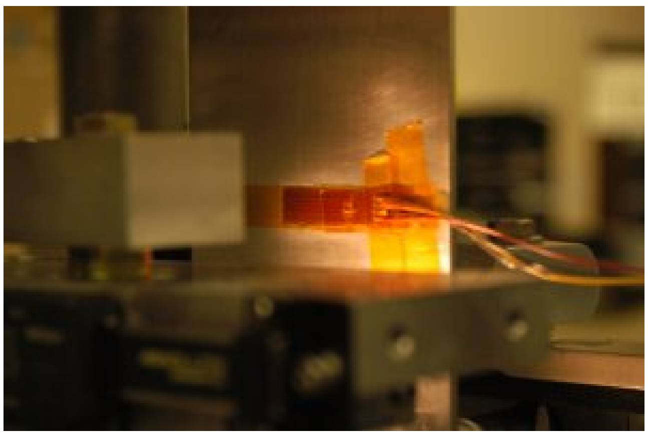

Engineers at Southwest Research Institute have developed new multi-layer thin films and combined them with magnetostrictive sensors to nondestructively detect and monitor defects in aircraft components. The probe and sensor were evaluated on an A-10 aircraft test article and successfully detected a crack and monitored its growth. Unlike MsS methods that evaluate flaws in pipeline, the MsS method for aircraft does not require the use of external magnets. Credit: Southwest Research Institute

As aircraft reach or exceed their design lifetimes, the U.S. Air Force is turning to advanced nondestructive evaluation methods to determine their fitness for continued duty. Southwest Research Institute has developed a flexible thin-film deposition process (as a follow-on effort to a recent project funded by the Defense Advanced Research Projects Agency) that will enable the fabrication of thin magnetostrictive sensors that can efficiently detect and monitor defects in aircraft without the need for costly teardowns or unnecessary inspections.

SwRI pioneered the use of magnetostrictive sensor (MsS) technology as a nondestructive evaluation tool for the pipeline industry. The method uses guided waves to rapidly detect corrosion and defects for assessing overall pipeline integrity. A magnetic field around the pipe generates the guided waves with a ferromagnetic strip and coil; however, this external magnet is impractical for the small components and confined spaces aboard aircraft.

"What we needed was an improved, lightweight, low-profile evaluation sensor that could maintain a residual magnetic field without the need for an external magnet," says Senior Research Engineer Clint J. Thwing of SwRI's Sensor Systems and Nondestructive Evaluation Technology Department.

Using internal research funds, the SwRI team developed a process for manufacturing thin films that, when combined with magnetostrictive sensor technology, effectively detect flaws without the need for an external magnet.

Deposited in an ultra-high vacuum environment, the thin films are layered with iron cobalt and iron terbium, then heat-treated. SwRI applied the multilayer deposition process to low-oxidation aluminum foil so that the thin film would be pliable and easy to apply. The technique for manufacturing multilayer thin-film magnetostrictive sensors is reproducible, and the resulting sensors have been shown to effectively monitor crack growth and determine the approximate size (cross section) of defects on a simulated A-10 aircraft structure.

Magnetostrictive sensors used by the pipeline industry are also limited by a "dead zone" - the distance associated with the time required for the excitation pulses to saturate the receiver. At 32 kHz, the dead zone extends 2 to 3 feet. This distance is inconsequential when testing a miles-long pipeline, but in aircraft bulkheads and fuselage components, the region to be inspected is usually only a few inches from the site of the monitoring probe. The new method minimizes the dead zone by using a much shorter wavelength or higher frequency signal.

"This new MsS technology is also ideal as a health and usage monitoring system, or HUMS," says Thwing. "Installed as onboard sensors and data acquisition systems, HUMS can help reduce costs, improve readiness and increase safety by identifying mechanical problems or maintenance issues while the aircraft remains in service."

With additional development, the new MsS technology will address the need for monitoring the structural components of today's high-cycle aircraft, such as T-37 and T-38 trainers, as well as A-10, F-16, F-15 and other military combat aircraft. It also has potential for commercial fleets.

Source: Southwest Research Institute

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