

LABORATORY ASSESSMENT OF VACUUM-BASED CRACK MONITORING SENSOR

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BACKGROUND

Various methods are currently available to monitor crack initiation and/or crack growth in real time. Each of these methods has inherent pros and cons associated with it, but unique applications sometimes require unique sensor capabilities or features.

This study performs a preliminary evaluation of a novel vacuum-based crack-monitoring sensor. The sensor and system was informally evaluated during testing that was performed to grow natural cracks in engine compressor blades without the use of starter notches.

The goal of this paper is to introduce an alternate tool for crack monitoring.

EXTRACTS OF FINDINGS -

Air Force Research Laboratory/Systems Support Division's experience was limited to the simplest version of the sensor, which contains two multi-channel manifolds. This particular configuration is ideal for detecting surface crack initiation on nearly any material in a laboratory environment. Other versions of the sensor can be configured to monitor crack growth.

The SMS system provides an alternate means of surface crack initiation detection and crack growth monitoring for the laboratory environment. The vacuum-based sensors are most similar in sensitivity and use to typical electronic crack detection and crack propagation gages, but this system may have more flexibility with sensor design and area coverage. Complex surface curvatures and/or shapes is not an issue for the vacuum-based technology. The system is applicable to nearly any material that has surface breaking flaws.

CONCLUSIONS

The SMS system proved to be capable of detecting crack initiation. Cracks as small as 0.045 inch were successfully detected during the AFRL/MLSA testing, using sensors with 0.020 inch spacing between vacuum channels. Better results may have been attained under more controlled testing conditions and/or more precise sensor placement. SMS produces sensors with spacing as small as 250 microns (0.010 inch) that may be able to detect cracks as small as 0.010 inch.

The SMS system is user friendly. Minimal surface preparation and setup time is required.

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A potential application for the SMS system is on-aircraft crack initiation and crack growth monitoring. Extensive environmental testing and evaluation of system configurations is recommended prior to this application.

The system is currently limited to the laboratory environment, but has potential as an on-aircraft crack detection/monitoring system for airframe or engine structure/components. The following additional testing is recommended should SMS decide to pursue on-aircraft crack detection:

- *Testing which demonstrates reliable crack detection and zero false calls in an operational environment.*
- *Environmental testing to prove the sensors could withstand the operational environment on an aircraft (i.e., exposure to fuels and oils, temperature extremes, etc.).*
- *Verification that the sensor adhesive does not interact with various aircraft materials. Note: Preliminary chemical analyses indicated the adhesive did not adversely affect the Inconel 713 material tested.*

Evaluation of length of vacuum line and sensitivity of sensor, since some applications could require extensive lengths of vacuum line to make an on-aircraft system practical.
