(16)

Non-Destructive Inspection Using 3-D Synchronous Magnetic Imaging

David Gray[1]**,** David Berry[1], and Steve Poland[1], [1]Prime Photonics, LC, 1116 South Main Street, Blacksburg, VA, 24060

Although condition-based maintenance paradigms are becoming more widely applied in DoD and commercial applications, structural components are still typically lifed on a highly conservative model that is calculated by the manufacturer or maintainer based on a worst case "mission profile" and in-service hours. Due to limitations in non-destructive inspection techniques, transitioning to a condition based maintenance operational mode is currently not possible for many structural component applications.

Prime Photonics is developing a non-destructive inspection (NDI) technology, 3-D synchronous magnetic imaging system (3-D SMIS), that uses synchronous detection of magnetic and ultrasonic signatures to measure both surface and subsurface flaws in metallic and non-metallic structures. 3-D SMIS is showing promise in a wide range of NDI/NDE uses including characterizing surface contiguous cracks in ferrous and non-ferrous materials, locating and characterizing subsurface cracks within nonferrous (paramagnetic or diamagnetic) materials, and characterization of subsurface residual stresses. The technology offers a non-contact, high resolution inspection technique that does not require the austere environment necessary for ultrasonic, arrayed eddy current, or dye penetrant inspection techniques.

Our prototype interrogation system has demonstrated the ability to accurately detect surface defects and surface contiguous cracks of varying depths within ferrous and coated flat plate test specimens. The system enabled accurate localization and geometric characterization of slots and holes machined into the test specimens. In addition to surface features, subsurface defects were accurately detected with the prototype interrogation system. We will provide an overview of 3-D SMIS technology, review testing performed with both ferrous and non-ferrous materials, and discuss application of the technology to subsurface defect detection in structural components used in aerospace propulsion applications.

Follow on work is ongoing in applying the technique to non-ferrous systems as well, including titanium and aluminum alloys, with special focus on subsurface cracks in these alloys. Our initial results suggest that our system is also capable of imaging stress fields within non-ferrous specimens, and has particular promise in residual stress characterization. We are therefore looking to apply the 3D-SMIS technique to detection, localization, and characterization of flaws, cracks, and stress states in aircraft structural and propulsion systems.

Acknowledgment

This work was supported in part through a Phase I SBIR contract through the Air Force (contract number (FA8501-14-P-0042).