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Electronic Measurement for Residual Stress

The U.S. Air Force Aircraft Structural Integrity Program (ASIP) has a need to experimentally measure stress magnitude around fastener holes and develop theoretical models. The Cold-worked fastener holes are used on the A-10 aircraft to extend the fatigue life of various structural OEM and depot-level repaired components. The cold working process produces residual compressive stresses around the hole, retarding crack initiation and small crack growth that occur and accumulate during service.

Southwest Research Institute® (SwRI) has developed a novel eddy current probe capable of measuring small changes in electrical conductivity of the material around fastener holes caused by compressive residual stress. The probe, based on a four-coil design, is scanned inside the hole of a single- or multi-layer aluminum (Al) alloy structure and monitors each layer's conductivity around the hole. By using a proper detection technique, the signal from residual stress and the signal from plastic deformation around the hole are completely separated.

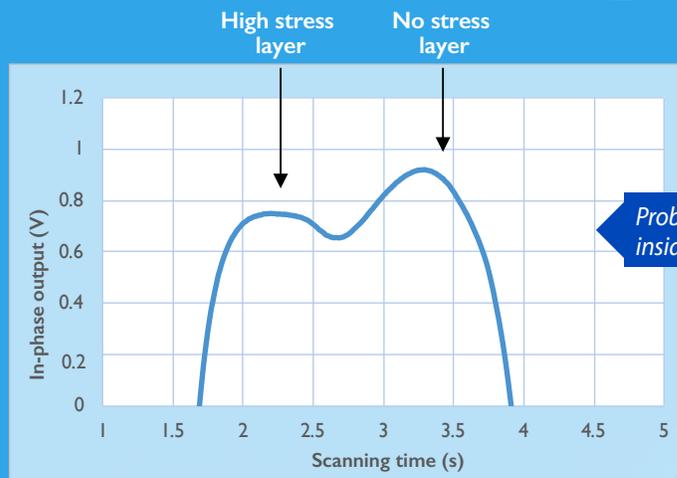
The eddy current probe can also differentiate between cold-worked holes having different degrees of cold expansion. This finding can be further exploited to monitor the relaxation of residual stresses due to in-service fatigue loading.

Features

- The eddy current probe can resolve very small changes in conductivity due to residual stress of about 0.1%.
- The probe can distinguish the stress level between low cold-expansion and high cold-expansion samples. A signal-to-noise ratio of about 20 dB has been obtained for Al 2024 samples.



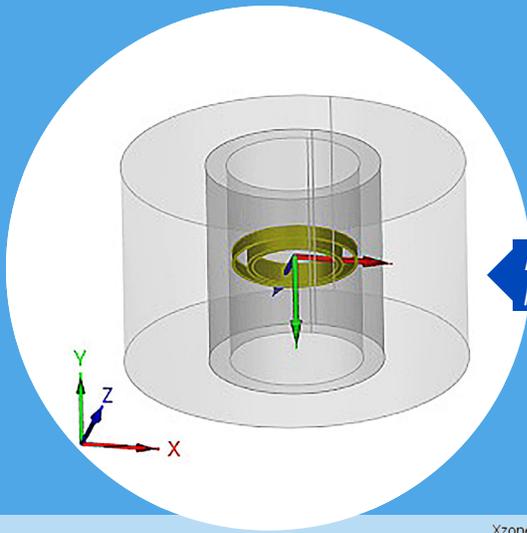
Eddy current probe inspecting a four-layer structure



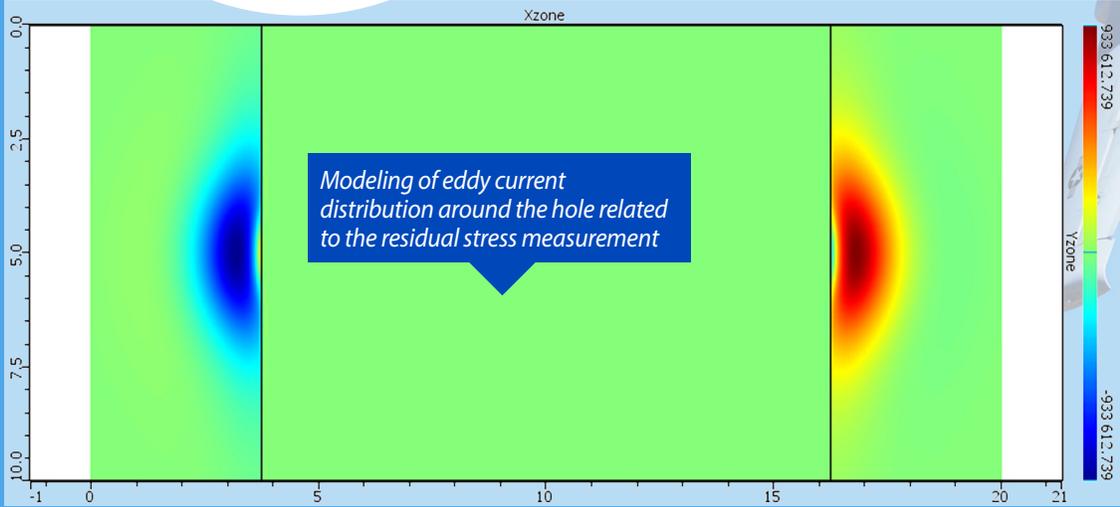
Probe output when scanned inside a two-layer structure



Advanced science. Applied technology.



Model of the eddy current probe inside a fastener hole



We welcome your inquiries.
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SOUTHWEST RESEARCH INSTITUTE

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