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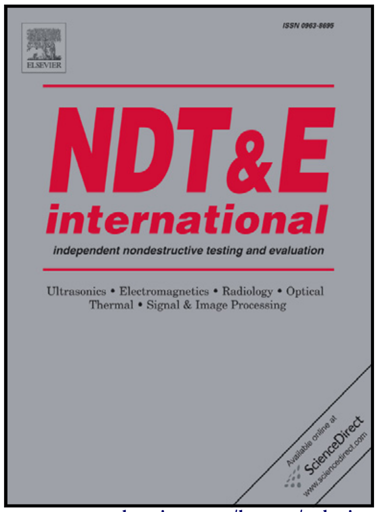

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Near Electrical Resonance Signal Enhancement (NERSE) in Eddy-Current Crack Detection

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An investigation was performed into the effects of operating an absolute eddy-current testing (ECT) probe at frequencies close to its electrical resonance. A previously undocumented defect signal enhancement phenomenon, resulting from associated shifts in electrical resonant frequency, was observed and characterised. Experimental validation was performed on three notch defects on a typical aerospace superalloy, Titanium 6Al-4V. A conventional absolute ECT probe was operated by sweeping through a frequency range about the electrical resonance of the system ($1-5MHz$). The phenomenon results in signal-to-noise ratio (SNR) peak enhancements by a factor of up to 3.7, at frequencies approaching resonance, compared to those measured at 1MHz. The defect signal enhancement peaks are shown to be a result of resonant frequency shifts of the system due to the presence of defects within the material. A simple, operational approach for raising the sensitivity of conventional industrial eddy-current testing is proposed, based on the principles of the observed near electrical resonance signal enhancement (NERSE) phenomenon. The simple procedural change of operating within the NERSE frequency band does not require complex probe design, data analysis or, necessarily, identical coils. Therefore, it is a valuable technique for improving sensitivity, which complements other ECT methods.

1 Introduction

Eddy-current testing (ECT) is a well-established non-destructive testing (NDT) technique, routinely implemented in industry for the inspection of safety-critical metallic components, because of its high sensitivity to small surface defects.

High-strength, low density superalloys are used frequently for many industrial applications, particularly in Aerospace [1]. The design and service lifetime of components is based on the assumption that the smallest defect that can be reliably detected by NDT techniques is present in the part. For this reason, research is generally focused on detecting smaller defects. Industrial eddy-current methods can reliably detect $0.75mm$ long (max $0.38mm$ deep) surface-breaking cracks, but achieving greater sensitivity is hampered by poor signal-to-noise ratios (SNR) [2]. Conventional ECT inspections operate in a range between 100Hz and 1MHz [3], so as to avoid the detrimental effects of environmental noise and the instabilities of electrical resonance. However, superalloys typically have very low electrical conductivities, leading to relatively large electromagnetic skin-depths at these frequencies. As a result, conventional

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