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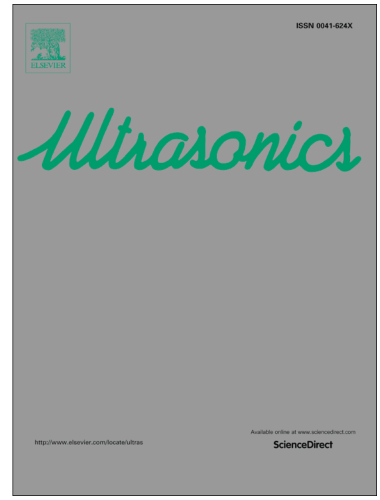


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# High-Frequency Ultrasonic Methods for Determining Corrosion Layer Thickness of Hollow Metallic Components

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Highlights

- Demonstration of high-frequency ultrasonic methods for measuring internal corrosion
- 125-MHz piezoelectric transducers and broad band laser-ultrasonic are employed.
- The NDT method can be effectively used in real application.

**Abstract** Corrosion in internal cavity is one of the most common problems occurs in many hollow metallic components, such as pipes containing corrosive fluids and high temperature turbines in aircraft. It is highly demanded to non-destructively detect the corrosion inside hollow components and determine the corrosion extent from the external side. In this work, we present two high-frequency ultrasonic non-destructive testing (NDT) technologies, including piezoelectric pulse-echo and laser-ultrasonic methods, for detecting corrosion of Ni superalloy from the opposite side. The determination of corrosion layer thickness below ~100 micrometers has been demonstrated by both methods, in comparison with X-CT and SEM. With electron microscopic examination, it is found that with multilayer corrosion structure formed over a prolonged corrosion time, the ultrasonic NDT methods can only reliably reveal outer corrosion layer thickness because of the resulting acoustic contrast among the multiple layers due to their respective different mechanical parameters. A time-frequency signal analysis algorithm is employed to effectively enhance the high frequency ultrasonic signal contrast for the piezoelectric pulse-echo method. Finally, a blind test on a Ni superalloy turbine blade with internal corrosion is conducted with the high frequency piezoelectric pulser-receiver method.

**Keywords** Non-destructive test, Internal Corrosion, Laser-ultrasonic, Piezoelectric pulse-echo, Ultrasonic Wave

## 1. Introduction

Corrosion is one of the most common phenomena occurs in many hollow components, such as pipes containing corrosive fluid or gases and high temperature turbines in aircraft [1-4]. The corrosion inside the hollow components will either form corrosion layers or reduce the wall thickness due to material loss. Early detection of the corrosion inside the hollow components can avoid catastrophic consequences of structural failures. Due to the small dimensions of many hollow components, the internal surfaces are often not accessible. Sometimes the difficulty in determining the extent of the corrosion and the remaining base metal