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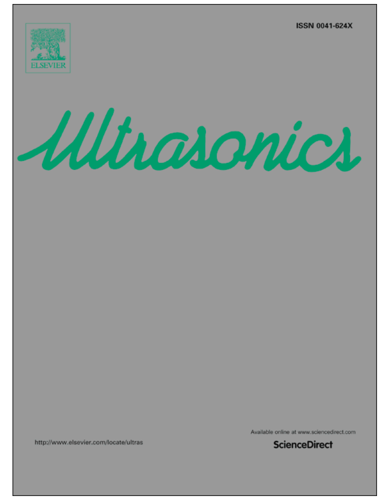

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ACCEPTED MANUSCRIPT

Effect of microstructural elongation on backscattered field: intensity measurement and multiple scattering estimation with a linear transducer array

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Abstract

The effect of microstructural elongation on ultrasonic backscattered fields was studied. Two methods for determining the elongation direction of macrozones in titanium alloys, using the anisotropic spatial coherence of the backscattered field, are presented. Both methods use a phased array attached on a rotative holder that records the array response matrix at several angles. Two titanium alloys were investigated : TA6V and Ti17. TA6V exhibited a strong macrozone elongation, whereas Ti17 macrozones were found equiaxial. The first method is based on the measurement of backscattered intensity in function of the probe angle relative to the macrozones elongation direction. An angular dependence of backscattered intensity is observed in presence of elongated scatterers, and their elongation direction is collinear with the probe direction corresponding to a minimal intensity. This variability is linked to both piezoelectric shape and the backscattered field spatial properties. The second method is based on the measurement of the relative proportion of single to multiple scattering in a diffusive media, using a simplified version of the single scattering filter developed in A.Aubry and A.Derode, Phys. Rev. Lett. 102, 084301 (2009). It allows the measurement of the level of multiple scattering : both titanium alloys exhibited strong multiple scattering. The elongation direction was determined as the direction of minimal multiple scattering. Furthermore, these results were confirmed by the measurement of the coherent backscattering cone on both samples.

1. Introduction

Titanium alloys are extensively used in the aerospace industry to create critical parts of jet engines or landing gears. They are light and very resistant to extreme conditions imposed to these parts. Titanium alloys are complex multiphasic polycrystals.[1] Their microstructures are extremely varied, leading to very different ultrasonic behaviours from one alloy to another. During ultrasonic evaluation, these alloys are known to present high levels of backscattered noise compared to other materials. This noise prevents the detection of low reflectivity and possibly harmful anomalies. Such anomalies are well known, for example, hard-α [2, 3] or High Density Inclusion.[4] Ultrasonic

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