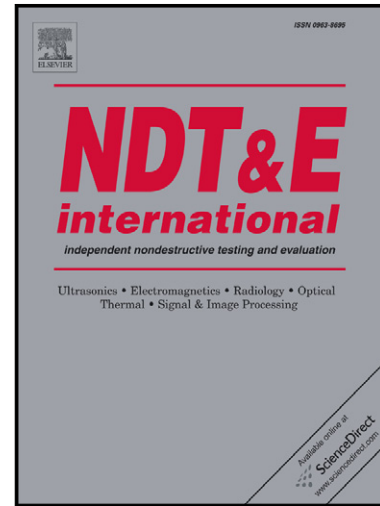


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# Ultrasonic detection of ductile-to-brittle transitions in free-cutting aluminum alloys.

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## Abstract

Resonant ultrasound spectroscopy (RUS) is applied to detect the ductile-to-brittle and brittle-to-ductile transitions in a AA6262 free-cutting aluminum alloy during thermal cycling. It is shown that the RUS method is sensitive enough to detect reliably the melting and solidification temperatures of micro-sized  $\text{Mg}_3\text{Bi}_2\text{-Bi}$  eutectic particles responsible for these transitions, although the volume fraction of the particles is very small ( $\sim 1\%$ ) and is even decreasing with the cycling. The proposed RUS approach is compared with differential scanning calorimetry (DSC); the latter method is shown to be unable to detect the transition temperatures especially when transition intervals are broad. The results reveal that the phase transitions of the eutectic particles exhibit a significant hysteresis and pronounced asymmetry between melting and solidification.

*Keywords:* Aluminum alloys; laser ultrasound; ductile-to-brittle transition; elastic constants; resonant ultrasound spectroscopy.

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## 1. Introduction

Phase transitions of micro- and nano-sized particles embedded in solid matrices exhibit several differences compared with the transitions of the same materials in bulk [1, 2, 3]. For example, the extensive acoustic and nuclear magnetic resonance studies of melting and freezing of various materials in porous glasses [4, 5, 6, 7, 8, 9] showed that the transition temperatures of such particles are shifted downwards, and there is always also an observable hysteresis between melting and solidification of the particles. There are, on the other hand, only very few works concerned so far with solid-to-liquid phase

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