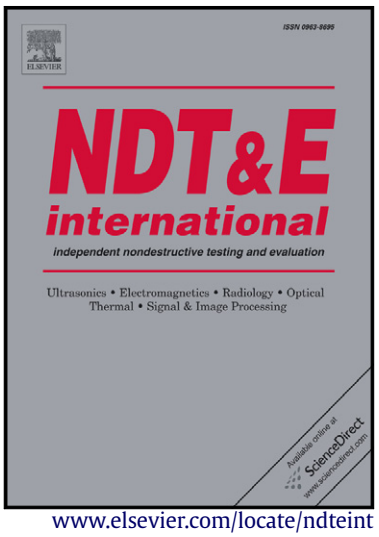

www.elsevier.com/locate/ndteint

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

Jitka Nejezchlebová, Hanuš Seiner, Martin Ševčík, Michal Landa, Miroslav Karlík

PII: S0963-8695(14)00120-0
DOI: http://dx.doi.org/10.1016/j.ndteint.2014.09.007
Reference: JNDT1649

To appear in: *NDT&E International*

Received date: 9 June 2014
Revised date: 17 September 2014
Accepted date: 23 September 2014

Cite this article as: Jitka Nejezchlebová, Hanuš Seiner, Martin Ševčík, Michal Landa, Miroslav Karlík, Ultrasonic detection of ductile-to-brittle transitions in free-cutting aluminum alloys, *NDT&E International,* http://dx.doi.org/10.1016/j.ndteint.2014.09.007

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

Jitka Nejezchlebová[a], Hanuš Seiner[b,1], Martin Ševčík[b], Michal Landa[b], Miroslav Karlík[a]

[a]*Faculty of Nuclear Sciences and Physical Engineering, Czech Technical University in Prague, Trojanova 13, 12000 Prague, Czech Republic.*
[b]*Institute of Thermomechanics, Academy of Sciences of the Czech Republic, Dolejškova 5, 18200 Prague, Czech Republic.*

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 Mg_3Bi_2-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.

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

*Corresponding author, hseiner@it.cas.cz