Asociación Argentina
de Mecánica Computacional

Resúmenes de Mecánica Computacional Vol I, pp. 123-123
C.I. Pairetti, M.A. Pucheta, M.A. Storti, C.M. Venier (Eds.)
S. Giusti, P. Sánchez, J. Mroginski (Issue eds.)
Rosario, November 5-8, 2024

EFFECT OF ALUMINA VOLUME FRACTION AND TEMPERATURE ON THE ULTRASONIC PROPERTIES OF ICE

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Keywords: Ice mechanical properties, Homogenization, Alumina dispersions, Finite Elements, MOOSE

Abstract. Non-destructive evaluation (NDE) enables the inspection and detection of manufacturing defects in high-performance parts obtained by additive manufacturing. In particular, ultrasonic testing (UT) is an NDE method that allows the examination of pieces thoroughly, but it has drawbacks when detecting defects in parts with complex shapes. To alleviate these difficulties, cryoultrasonic NDE is a technique recently developed to inspect metal parts with geometries that challenge the use of UT. This technique embeds the piece of metal in ice enriched with nano particles of the same material. This type of ice is capable of transmitting the ultrasonic signal more clearly.

Cryoultrasonic has already proven ice as a superior couplant to water and is a potential candidate for helping the field of NDE jump over the complex shaped component hurdle. Further increasing the density and compressional wave velocity in the ice may allow Cryoultrasonic to maximize its benefits.

This study will investigate the viability of using modified ice as an ultrasonic couplant by mixing solid alumina particles into ice. A variety of volume fractions ice/alumina in 2D and 3D are investigated to build an understanding of the effect of alumina volume fraction and temperature, on the ultrasonic properties, through numerical homogenization techniques. These results will be contrasted with theoretical and experimental velocity models obtained by the experimental group.

We use the finite element based Multiphysics Object Oriented Simulation Environment (MOOSE, https://mooseframework.org) for implementing the proposed periodic RVE scheme.

ISSN: 3072-7723 DOI: 10.70567/rmc.v41i12.187