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REPRESENTATIVE VOLUME ELEMENT (RVE) ANALYSIS FOR MECHANICAL CHARACTERIZATION OF ICE WITH METALLIC INCLUSION OF MICRO/NANO PARTICLES

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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 micro/nano particles of the same material. This type of ice is capable of transmitting the ultrasonic signal more clearly. Although preliminary results have been promising, practical issues require a more profound study of the size and shape of the micro/nano particles.

In this work, we focus our study on determining the effective material properties of ice with a random distribution of micro/nano metallic particle inclusion through numerical homogenization techniques, implementing periodic representative volume element (RVE) based multiscale modeling. We use the finite element based Multiphysics Object Oriented Simulation Environment (MOOSE, https://mooseframework.org) for implementing the proposed periodic RVE scheme.