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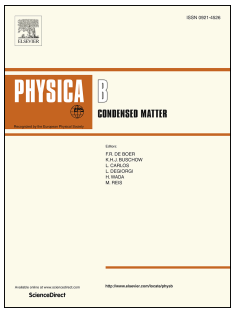

Enthalpy-based equation of state for highly porous materials employing modified sphere fluid model

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Enthalpy-based equation of state for highly porous materials employing modified soft sphere fluid model

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Abstract

Enthalpy-based equation of state based on a modified soft sphere model for the fluid phase, which includes vaporization and ionization effects, is formulated for highly porous materials. Earlier developments and applications of enthalpy-based approach had not accounted for the fact that shocked states of materials with high porosity (e.g., porosity more than two for Cu) are in the expanded fluid region. We supplement the well known soft sphere model with a generalized Lennard-Jones formula for the zero temperature isotherm, with parameters determined from cohesive energy, specific volume and bulk modules of the solid at normal condition. Specific heats at constant pressure, ionic and electronic enthalpy parameters and thermal excitation effects are calculated using the modified approach and used in the enthalpy-based equation of state. We also incorporate energy loss from the shock due to expansion of shocked material in calculating porous Hugoniot. Results obtained for Cu, even up to initial porosities ten, show good agreement with experimental data.

Keywords: Porous materials, Hugoniot, Equation of state, Enthalpy-based EOS, Soft sphere model, Generalized Lennard-Jones model.

1. Introduction

Enthalpy-based equation of state, originally proposed by Rice and Walsh [1] to model the Hugoniot of water, relates specific volume and specific enthalpy via enthalpy parameter and treats pressure and temperature as independent thermodynamic variables. This approach is quite analogous to the Mie-Grüneisen equation of state which treats volume and temperature as independent variables. A key assumption used in applications of enthalpy-based approach, which provides good accuracy, is that the enthalpy parameter depends only on pressure. This leads to the result that constant pressure specific heat is either a constant or a function of entropy [2]. However, a weak dependence of the enthalpy parameter on temperature is accommodated in the formalism discussed below. Shock wave propagation in porous materials, binary mixtures and

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