

Accepted Manuscript

Coupled elastoplasticity and plastic strain-induced phase transformation under high pressure and large strains: Formulation and application to BN sample compressed in a diamond anvil cell

Biao Feng, Valery I. Levitas



PII: S0749-6419(17)30118-3

DOI: [10.1016/j.ijplas.2017.05.002](https://doi.org/10.1016/j.ijplas.2017.05.002)

Reference: INTPLA 2200

To appear in: *International Journal of Plasticity*

Received Date: 6 March 2017

Revised Date: 8 May 2017

Accepted Date: 12 May 2017

Please cite this article as: Feng, B., Levitas, V.I., Coupled elastoplasticity and plastic strain-induced phase transformation under high pressure and large strains: Formulation and application to BN sample compressed in a diamond anvil cell, *International Journal of Plasticity* (2017), doi: 10.1016/j.ijplas.2017.05.002.

This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting proof before it is published in its final form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.

Coupled Elastoplasticity and **Plastic** Strain-Induced Phase Transformation under High Pressure and Large Strains: Formulation and Application to BN Sample Compressed in a Diamond Anvil Cell

Biao Feng^{1,2} and Valery I. Levitas^{3,4*}

1) *Department of Aerospace Engineering, Iowa State University, Ames, Iowa 50011, USA*

2) *Los Alamos National Laboratory, Los Alamos, New Mexico 87545, USA*

3) *Departments of Aerospace Engineering, Mechanical Engineering, and Material Science and Engineering, Iowa State University, Ames, Iowa 50011, USA*

4) *Ames Laboratory, Division of Materials Science and Engineering, Ames, Iowa 50011, USA*

Abstract

In order to study high-pressure phase transformations (PTs), high static pressure is produced by compressing a thin sample within a high strength gasket in a diamond anvil cell (DAC). However, since a PT occurs during plastic flow, it is classified and treated **here** as a **plastic** strain-induced PT. A thermodynamically consistent system of equations for combined plastic flow and **plastic** strain-induced PTs is formulated for large elastic, plastic, and transformation strains. The Murnaghan elasticity law, pressure-dependent J_2 plasticity (both dependent of the concentration of a high-pressure phase), and **plastic** strain-induced and pressure-dependent PT kinetics are utilized. A computational algorithm within finite element method (FEM) is presented and implemented in a user material subroutine (UMAT) in the FEM code ABAQUS. Combined plastic flow and strain-induced PT from the highly-disordered hexagonal boron nitride (hBN) sample to a superhard wurtzitic wBN is simulated within the rhenium gasket for pressures up to 50 GPa. The evolution of the fields of stresses and plastic strains, as well as the concentration of phases in a sample is obtained and discussed in detail. Stress-strain fields in a gasket and diamond are presented as well. **An unexpected shape of the deformed sample with almost complete PT in the external part of the sample that penetrated the gasket was found. Obtained results demonstrated the difference between material and system behavior which are often confused by experimentalists. Thus, while plastic strain-induced PT may start (and end) at plastic straining slightly above 6.7 GPa, it is not visible below 12 GPa. It**

* Corresponding author.

Email: vlevitas@iastate.edu (Valery Levitas); fengbiao11@gmail.com (Biao Feng)

Download English Version:

<https://daneshyari.com/en/article/5016751>

Download Persian Version:

<https://daneshyari.com/article/5016751>

[Daneshyari.com](https://daneshyari.com)