Multiphase EOS for Cerium

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Summary: We show the coupling between a good theoretical description of cerium with carefully designed experiments. The Aptekar-Ponyatovsky model has been shown to adequately capture many of the dynamic properties of the (γ-α) phase transition.

Introduction

Over the past several years there has been a focused interest in developing a multiphase equation of state (EOS) for cerium metal that is experimentally validated. This work has produced a number of high quality publications detailing both the theoretical and experimental work of this multi-lab emphasis on a particular metal [1-13]. The large amount of interest in cerium stems from many of its interesting properties, namely, large volume collapse low pressure phase transition, multiple phases accessible under both static and dynamic loading conditions, the abnormal compressibility near the low pressure phase transition (γ® α), and the isomorphic transition.

Results and Discussion

The application of the Aptekar-Ponyatovsky (AP) model [14,15] for cerium isomorphism assuming a temperature dependence for the mixing Gibbs energy adequately captures many of the salient features of the (γ-α) phase boundary. Dynamic experiments have been performed across a wide region of phase space. Calculations involving the multi-phase EOS detailed in ref. [12] show a large amount of agreement between the experiments and hydrodynamic simulations.

In looking at the dynamic research of cerium, the multi-phase equation of state that has been developed serves as a stepping stone toward further work into such areas as multi-phase strength, ejecta formation, understanding the role of the epsilon boundary in dynamic experiments. Recent heated diamond anvil experiments combined with double shock experiments seem to suggest that a further refinement of the epsilon portion of the phase space needs to be done.

Conclusions

The application of the current form of the multi-phase equation of state for cerium including the AP model for the (γα) phase region has proved to be a useful tool in predicting/analyzing the dynamic behavior of cerium. Further refinements may be necessary as indicated by recent dynamic and static experimental efforts.

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