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# Crystal orientation effects in the shock response of single-crystal tin

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## Abstract

Tin exhibits strongly anisotropic mechanical behaviour arising from its tetragonal β-phase crystal structure. Under dynamic loading, this anisotropy may influence a sequence of distinct shock and release phenomena, including yielding, structural phase transitions, and ultimately failure. An open question is whether anisotropic behaviour persists through these transitions, or whether it is progressively diminished as inelastic deformation and phase transformation dominate the response. In this talk, I present a combined experimental and computational investigation of the shock compression and release behaviour of tin conducted at the University of Oxford. Plate-impact experiments are performed on single crystals oriented along the [100], [110], and [001] axes, enabling direct assessment of crystallographic orientation effects on the Hugoniot Elastic Limit (HEL), the onset of the β to γ phase transition, and spall response. Soft-recovery experiments followed by EBSD analysis are used to characterise post-shock microstructure and texture evolution, with complementary molecular dynamics simulations employing a machine-learning interatomic potential to explore candidate transformation mechanisms. The results show a strong dependence of the HEL on crystal orientation, with measured wave speeds in good agreement with a third-order elastic model. In contrast, at higher shock stresses, this orientation dependence largely vanishes: both the β to γ

phase transition pressure and spall strength are found to be insensitive to the initial crystal orientation. Possible mechanisms underlying this transition from anisotropic to effectively isotropic response are discussed.

**Keywords:**
shock compression tin single crystal phase transition