Shock-Induced Superheating-Melting and Geophysical Implications

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Superheating is a metastable state with the long-range order of a solid sustained above the equilibrium melting temperature, and a rare phenomenon. The limit of superheating was attempted realistically by assuming an arbitrary critical nucleation rate [1]. Based on classical nucleation theory and supercooling experiments, we developed the systematics relating materials properties to the maximum superheating (supercooling) and heating (cooling) rates, consistent with shock wave experiments, molecular dynamics simulations and Landau-type models [2-5]. Superheating is more achievable under ultrafast heating rate. There are strong indications of superheating in shock experiments on translucent solids using optical pyrometry [6-8] and on single crystal Al during dynamic spallation [9].

High strain- and heating-rates experiments such as shock wave loading are an essential complement to diamond-anvil cell techniques for investigating translucent minerals and opaque metals [10]. We present an exhaustive survey on superheating-melting behavior of alkali halides, silicates and metals, and their geophysical implications.

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