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Shock induced crystallization of amorphous Nickel powders[1]

MATHEW CHERUKARA, ALEJANDRO STRACHAN, Purdue Univ — Recent experimental work has shown the efficacy of amorphous Ni/crystalline Al composites as energetic materials, with flame velocities twice that of a comparable crystalline Ni/crystalline Al system. Of further interest is the recrystallization mechanisms in the pure amorphous Ni powders, both thermally induced and mechanically induced. We present large-scale molecular dynamics simulations of shock-induced recrystallization in loosely packed amorphous Nickel powders. We study the time dependent nucleation and growth processes by holding the shocked samples at the induced pressures and temperatures for extended periods following the passage of the shock (up to 6 ns). We find that the nanostructure of the recrystallized Ni and time scales of recrystallization are dependent on the piston velocity. At low piston velocities, nucleation events are rare, leading to long incubation times and a relatively coarse nanostructure. At higher piston velocities, local variations in temperature due to jetting phenomena and void collapse, give rise to multiple nucleation events on time scales comparable to the passage of the shock wave, leading to the formation of a fine-grained nanostructure. Interestingly, we observe that the nucleation and growth process occurs in two steps, with the first nuclei crystallizing into the BCC structure, before evolving over time into the expected FCC structure.

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Mathew Cherukara
Purdue Univ

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