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Transformation of Shock-Compressed Pyrolytic Graphite to Diamond: Role of Microstructure[1]

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The response of highly-oriented pyrolytic graphite (HOPG) to shock wave compression depends strongly on its microstructure: highly oriented ZYB-grade HOPG showed evidence for rapid transformation to a high density phase; less oriented ZYH-grade HOPG did not [Erskine and Nellis, 1991]. To gain insight into these findings and to understand the rapid phase transformation in ZYB-grade HOPG, theoretical and experimental examinations of shocked HOPG were carried out. Numerical simulations of the previous measurements resulted in the following findings for ZYB-grade HOPG: completion of the transformation in less than 10 ns; the response of the high density phase matches cubic diamond. Also, measured wave profiles for ZYB- and ZYH-grade HOPG, shocked to stresses below the phase transformation onset, revealed significant differences in their elastic-inelastic response. ZYB-grade HOPG exhibits elastic-inelastic waves with large elastic wave amplitudes. In contrast, single overdriven waves for ZYH-grade HOPG suggest negligible elastic limits. These results show that the elastic-inelastic response of shocked pyrolytic graphite depends strongly on the orientational order. They also suggest that rapid phase transformation in shocked ZYB-grade HOPG may be due to large elastic compression.

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