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Shock-Wave Exploration of the High-Pressure Phases of Carbon[1]

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The high energy density behavior of carbon, particularly in the vicinity of the shock melt boundary and the theoretically predicted diamond-liquid-bc8 triple point, is of broad scientific interest, and is of particular interest to those studying planetary astrophysics and inertial confinement fusion. Previous experimental data in the several hundred GPa pressure range in the vicinity of the melt boundary have only been able to provide data with accuracy levels that permit qualitative comparison with theory. Here we present shock-wave experiments on carbon using a magnetically driven flyer plate technique with sufficient accuracy to enable quantitative comparison with quantum molecular dynamics (QMD) simulations. Our QMD simulations indicate subtle but measurable changes in the shock $U_s - u_p$ behavior as the shock Hugoniot traverses the diamond-liquid and the bc8-liquid coexistence regions and a distinct change in slope at the diamond-liquid-bc8 triple point. The data is in very good agreement with the theoretical predictions and provides strong evidence for the existence of the diamond-liquid-bc8 triple point along the principal Hugoniot for diamond.

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