Surprising" phase behavior of pure carbon: Is diamond metastable at high pressures?

Reinhard Boehler[1,2]

[1] Geophysical Laboratory, Carnegie Institution of Washington, 5251 Broad Branch Road NW, Washington, DC 20015

[2]Oak Ridge National Laboratory, Oak Ridge, TN 37831

Flash laser heating in diamond anvil cells has been performed to melt diamond up to 37.5 GPa and 4500K using three different methods and three different starting materials: graphite, glassy carbon and diamond. In these experiments molten diamonds were confirmed by FIB/SEM images of the quenched samples. The melting slope of diamond is strongly negative, in contrast to all theoretical predictions.

This is the first direct measurement of diamond melting temperatures at high pressure supporting early predictions based on analogies in the phase behavior of the group IV elements carbon, silicon and germanium. For diamond, these analogies had been dismissed for over 30 years based on theoretical grounds. The results imply that, at very high pressure, diamond, seemingly stable in all static and shock experiments, must be outside its thermodynamic stability field. This could be comparable to its behavior at ambient pressures, where diamond exhibits remarkable stability when heated to several thousand degrees even though the thermodynamically stable form of carbon is graphite.