Direct measurements of the electrical resistivity and state functions of hot expended iron in the metal-nonmetal transition range

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Measurements have been performed on iron that expanded from the initial solid state by a factor of 2 to 9 under a supercritical pressure (>20 kbar). An iron foil strip (~30 μm) sandwiched between two sapphire plates (~3 mm) is heated by an electrical current pulse for less than 1 μs so that the Joule heat deposited into the sample achieves 4 to 6 the cohesion energy. Such experimental technique ensures sufficiently homogeneous heating and practically one-dimensional expansion of the foil strip. The current through the sample, the voltage drop across its length and the pressure near the sample surface are measured. From the measured quantities the electrical resistivity and pressure both as functions of density and internal energy are directly determined. This technique is described in detail for the measurements on aluminum in Ref. 1.

Present results show that the dependence of the electrical resistivity of iron on internal energy along isochores acquires a negative slope at a density that is about 4 to 5 times lower than the standard solid density that probably indicates transition into a nonmetallic state. The equation of state obtained, i.e., the dependence of pressure on internal energy and density in this work evidences that this transition is continues. Our data allows also the sound velocity of iron in the metal-nonmetal transition range to be obtained. The change in sound velocity across the transition range is discussed.

1. V. N. Korobenko and A. D. Rakhel, Phys. Rev. B, **75,** 064208 (2007).