Resistivity of Liquid Transition Metals on the Pressure-Dependent Melting Boundary

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The Earth's core cools by heat transport to the top of the core and removal of heat from the core-mantle boundary. Understanding core heat transport requires knowledge of the thermal and electrical conductivity of solid and liquid Fe and its relevant alloys. Stacey and Anderson (PEPI, 2001) proposed that electrical resistivity of a pure metal is constant along its P-dependent melting boundary. If confirmed, this invariant behavior could serve as a practical tool for low P studies to assess electrical resistivity of Earth's core, a property that has major implications for the geodynamo and thermal evolution of the core via related thermal conductivity. Since Earth's inner core boundary (ICB) is a melting boundary of mainly Fe, measurements of electrical resistivity of Fe at the melting boundary, under any P, would serve as a proxy for the resistivity at the ICB. Stacey and Loper (PEPI, 2007) accounted for s-d scattering in transition metals with partially filled d-bands and limited the proposal to metals with electrons of the same type in filled d-band metals. We are testing this proposal by high P,T measurements of electrical resistivity of d-band filled (Cu, Ag) and partially filled (Ni) transition metals in solid and liquid states. Experiments were carried out in 1000 ton cubic anvil and 3000 ton multi-anvil presses up to 5 GPa and 2023K. Two thermocouples placed at opposite ends of the wire sample served as T probes as well as 4-wire resistance electrodes in a switched circuit. A polarity switch was also used to remove any bias associated with current flow and voltage measurement using thermocouple legs. The observed large jump in resistivity at the high P melting T of each metal is consistent with its known phase diagram and with post-run compositional analyses by electron microprobe. The expected resistivity decrease with P and increase with T were found and comparisons with 1atm data are in very good agreement. The resistivity values measured to date at the melting T at high P of each metal appear to mimic its 1 atm value.