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Electrical Resistivity of Molten Ni at High Pressures and Comparison with Preliminary Results on Liquid Fe

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Characterization of transport properties of liquid Ni and Fe at high pressures has important geophysical implications for heat flow and dynamo action in terrestrial planetary interiors. Ni is a close electronic analogue of Fe and it is also integral to the Earth's core. We report the measurements of electrical resistivity of solid and liquid Ni, and the preliminary results for Fe at pressures 3 –9 GPa using a 3000 ton multi-anvil press.

A 4-wire method, along with a rapid acquisition meter and polarity switch, were used to overcome experimental challenges such as melt containment and maintaining sample geometry, and to mitigate the extreme reactivity/solubility of liquid Ni and Fe with most thermocouple materials. Thermal conductivity was calculated using the Wiedemann-Franz law.

Electrical resistivity of solid Ni and Fe exhibits the expected pressure dependence and is consistent with earlier experimental values which are mainly at 1 atm. Our results demonstrate that electrical resistivity of liquid Ni remains invariant along the pressure and temperature-dependent melting boundary, which is in disagreement with earlier prediction for liquid transition metals. However, preliminary results on Fe indicate that electrical resistivity of decreases along its melting boundary.

Potential reasons are examined qualitatively for such behaviour in Ni through the impact of pressure-independent local short range ordering on electron mean free path and the possibility of a constant Fermi surface at the onset of melting.

While the correlation among metals obeying the Kadowaki-Woods ratio and the group of late transition metals with unfilled d-electron band displaying anomalously shallow melting curves suggest similar thermoelectric transport behaviour, Fe appears to behave differently than Ni, Pt and Mo. This is consistent with earlier theoretical predictions, however comprehensive physical understanding of such behaviour is insufficient at the moment.

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