# Advances in a high pressure-temperature experiment for understanding thermal transport property of the Earth’s core

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Heat flow inside of the Earth controls the scale of dynamics and thermal evolution in each layer of the Earth such as core and mantle. Electrical resistivity and related thermal conductivity of iron-light element alloys at high pressure (*P*) and temperature (*T*) are key parameters to constrain the heat flux in the core. Static high *P-T* experiments using a laser-heated diamond anvil cell (LHDAC) are now capable of obtaining the thermal and electrical conductivities of iron at the Earth’s core conditions, but the obtained values are inconclusive so far [1]. Disadvantages in the existing LHDAC technique may cause the discrepancy, and thus technical developments for the high *P-T* conductivity measurements of iron alloy are required.

We have recently developed an internally resistive heated DAC technique to be capable of measuring the electrical conductivity of a metal sample via the four-terminal method [2]. A new instrument to determine the thermal diffusivity of metal *in-situ* at high *P-T* has been made based on the combination of the thermoreflectance method and the LHDAC system [3]. Such technical progress provided us chances to determine the thermal transport properties of core materials at the *P-T* conditions relevant to the Earth’s deep interior.

We report our new experimental results of the electrical resistivity measurements of liquid iron and Fe-Si alloys at high *P-T*conditions using the four-terminal method in an internally heated DAC. The *T* dependence of electrical resistivity of *hcp* Fe-Si alloys was suppressed as both Si concentration and *T* increased, which indicates the resistivity saturation phenomenon: the electrical resistivity of metal asymptotically approaches the "saturation resistivity". The obtained saturation resistivities for *hcp*Fe-Si alloys are comparable to those for *hcp* pure Fe at around 100 GPa. Resistivity increase in iron across melting was observed to 70 GPa. Besides, high-*T* thermal diffusivity of iron was obtained to Mbar pressure range utilizing the combination of the thermoreflectance method and LHDAC system. These new results shed light on the problem of the Earth’s core conductivity and thermal evolution.

References

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