Electrical resistivity of hcp Fe-Si alloys at high pressure and temperature

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Silicon (Si) has been repeatedly suggested to be the major light element in the Earth’s core that mainly consists of iron [1]. Alloying the light element(s) affects a variety of physical properties of iron. Electrical and thermal conductivities strongly constrain the dynamics and thermal evolution of Earth’s core and these parameters are linked by the Wiedemann-Franz law ($\kappa = \sigma LT$; κ: thermal conductivity, σ: electrical conductivity, L: Lorenz number, T: absolute temperature). However, measurements of electrical and thermal conductivities under static condition at extremely high pressures (P) and temperature (T) are limited for pure iron [2], [3]. The estimates of the core conductivity considering the effect of light element(s) have been done based on the resistivity saturation model, but the validity of the model at the core condition is unclear [4], [5].
In this study, we examined electrical resistivity (the reciprocal of electrical conductivity) of Fe-2, 4 and 6.5 wt.%Si at high P-T conditions in an internally-heated diamond anvil cell (IHDAC) up to 99 GPa and 2910 K. Our results of electrical resistivity of hcp Fe-Si alloys showed its nonlinear temperature dependence, indicating the occurrence of the resistivity saturation. The resistivity saturation in Fe-Si alloys observed in this study supports the notion of high core conductivity and resulting molten lowermost mantle and young inner core.

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