

Technical improvements for viscosity measurement of liquid iron-alloy

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Iron-alloy is a major component of planetary core and its viscosity is closely related to convectional behavior of the Earth liquid outer core and time scale of core formation.

Viscosities of liquid Fe, Fe-S and Fe-C have been measured under high pressure using X-ray radiography falling sphere method. However, there were some problems related to accuracy for the falling velocity and to reactivity between marker sphere and metallic sample. Since image capturing and recording system has been developed, we are able to get the images with capture rate of 125 fr./s in maximum. Such high speed rate is quite efficient to get accurate viscosity data especially for low viscosity metallic liquid.

Metallic marker sphere can react with iron-alloy sample during falling to some extent. Although tailoring sphere which consists of Pt core and ruby shell has been used, its large diameter and large uncertainty of its density were still problematic. In this study, we used Al₂O₃ coated Re sphere and we could get profiles of falling sphere without any reduction of sphere sizes.

In order to prevent the falling during partial melting of the sample and to control temperature conditions, we have developed two-step falling sphere technique which consists of silicate trapper layer above the iron-alloy sample. Recently, we have used silicate trapper with small diameter to delay the sphere falling.

Using these improvements, we have measured the viscosity of liquid Fe-C. Detailed results will be discussed in the session. Furthermore, in order to examine the pressure effect on viscosity, viscosity of liquid Fe-S has been measured using TEL5 cell assembly with LaCrO₃ furnace up to 16 GPa and 1527 K.