Melting relations of the system Fe-C-S at high-pressures and high-temperatures and chemical composition of planetary core

Satoru Urakawa[1]; Masaki Kato[2]; Nobuyuki Takahashi[2]; Tomoo Katsura[3]

[1] Dept.of Earth Sci., Okayama Univ.; [2] Dept. Earth Sci., Okayama Univ.; [3] ISEI, Okayama Univ.

Carbon is one of the candidates of lightening elements of the Earth's outer core, such as sulfur, oxygen, and hydrogen. These light elements were alloyed with molten iron to incorporate into the core during core-mantle separation. Melting relations of iron and light elements at high pressures are fundamental to understand the chemical composition of the core. Experimental study of Fe-Fe3C system showed that molten iron can dissolve about 5 wt.% carbon at 5 GPa [1], which amounts to half of the light elements in the outer core. During core formation, however, other abundant lightening elements such as sulfur must be taken into account. We, therefore, study the melting relationships of the system Fe-Fe3C-FeS up to 10 GPa by using KAWAI-type high-pressure apparatus. Fe-FeS is a simple eutectic system in this pressure range. Addition of carbon to Fe-FeS generates the large immiscible liquids region between sulfide liquid and C-rich metallic liquid at 0.1 MPa. Our results show this immiscible liquids field shrinks with pressure and disappears up to 10 GPa. We examine the effect of pressure on the solubility of carbon and sulfur in the liquid by an electronprobe analysis of quenched sample. Carbon solubility in liquid increases with pressure to 5 GPa, but it is nearly constant above 5 GPa at which diamond is a liquidus phase. Contrary to the prediction of Wood [1] in which a large immiscible liquids region still exists at the pressure of the core-mantle boundary, even at 10 GPa, the liquid in the system Fe-Fe3C-FeS is miscible and carbon can be dissolved in molten iron together with sulfur. Our results indicate that sufficient amount of carbon should incorporate into the Earth's core together with more abundant sulfur during core separation process.

[1] B.J. Wood, Earth Planet. Sci. Lett. 117 (1993) 593.
[2] C. Wang et al., ISIJ Inter. 31 (1991) 1292.