Partitioning of Si and S between solid and liquid in the Fe-Si-S system up to 25 GPa with implications for the distribution of Si and S in a partially solidified core

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Planetary cooling leads to solidification of any initially molten core. Both S and Si have been suggested to be present in planety's cores. We conducted high-pressure experiments to investigate the partitioning behavior of Si and S in the Fe-Si-S system up to 25 GPa. The starting material contains ~ 6 wt.% S and ~ 4 wt.% Si. The liquidus temperature in this study is about 50 °C lower than that in the Fe-S binary system for the same S concentration in the melt at 21 GPa. Similar to the binary system, S prefers to partition into liquid and its content in the liquid increases with decreasing temperature. However, Si solubility in the solid phase is almost independent of temperature, controlled by the bulk Si content. The Si content in the liquid phase increases with temperatrue, accompanied with the decrease in the S content. We fitted the partition coeffcient (K_D^{Si}) of Si between solid and liquid in correlation with experimental P, T and S concentration in liquid. At same pressure, the $\log(K_D^{Si})$ is only linearly depedent on 1/T. The higher temperature (lower 1/T), the higher $\log(K_D^{Si})$. With increase of pressure, the slope of the linear correlation beteween $\log(K_D^{Si})$ and 1/T will decrease. The Si partition coeffcient is also strongly dependent of the S concentration in liquid. Our experimental results have directly applications to the distribution of Si and S between the solid inner core and the liquid outer core in small terrestrial planets such as Mars and Mercury. Understanding the pressure effect on the partitioning coefficients will allow us to further constrain the distribution of Si and S in the Earth's core.