Studies on the physical properties of iron-nickel sulfides are important to investigate the formation, the evolution and the present state of the planetary core. We found a new nickel sulfide phase with Ni$_3$S composition, which was observed as a liquidus phase in a quenched sample of melting experiments of the system Ni-S at 10 GPa. In order to elucidate the structure and the stability filed of the Ni$_3$S phase, we were carried out in situ observation on this phase using multi anvil apparatus combined with synchrotron radiation. High-pressure and temperature experiments were conducted up to 10 GPa by energy dispersive method using the MAX80 system installed at AR NE5C at Photon Factory of KEK. Powder X-ray diffraction revealed that the new Ni$_3$S phase has the Fe$_3$P-type structure. As the Fe$_3$S phase, which is stable at higher pressure than about 20 GPa, also takes the Fe$_3$P structure, the Fe$_3$S and the Ni$_3$S is thought to make a complete solid solution. The Ni$_3$S phase is stabilized above 5 GPa, and it breaks down into the Ni and the Ni$_3$S$_2$ below 5 GPa. The Ni$_3$S phase melts incongruently into Ni and liquid around 700 K at 6 GPa and its melting temperature gradually increases with pressure. The stability field of the Ni$_3$S phase, therefore, expanded to higher temperature at high pressure. The addition of Ni to Fe$_3$S must affect not only the stability field but also the physical properties such as bulk modulus.

Keywords: core, nickel sulfide, Fe$_3$S

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