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放射光 X 線回折法による $Al_{65}Cu_{20}Fe_{15}$ 正 20 面体準周期結晶の安定性に関する研究
Study on the stability of the $Al_{65}Cu_{20}Fe_{15}$ icosahedral quasicrystal using Synchrotron X-ray diffraction method

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The stability of the $Al_{65}Cu_{20}Fe_{15}$ icosahedral quasicrystal at high pressure and high temperature has been investigated using synchrotron X-ray diffraction method. High pressure *in situ* XRD experiments ware performed up to 104 GPa, and high pressure and high temperature *in situ* XRD experiments ware performed at the pressure points of 11, 24, 33, 57, 67, 104 GPa up to temperature of about 2500 K. The high pressure experiments revealed that five characteristic XRD peaks of the $Al_{65}Cu_{20}Fe_{15}$ icosahedral quasicrystal remained up to 104 GPa at room temperature, while a new peak appeared at the point of d = 2.90 Å above 89 GPa. The six-dimentional lattice parameter, a_{6D}, was continuously contracted from 12.5 Å to 11.2 Å with pressure. The bulk modulus of the $Al_{65}Cu_{20}Fe_{15}$ icosahedral quasicrystal started to change around 70 GPa. This result suggested that the $Al_{65}Cu_{20}Fe_{15}$ icosahedral quasicrystal was transformed to high pressure phase at about 70 GPa. The high pressure and high temperature experiments showed that a different phase (high-temperature phase) occurs as a function of the temperature. The phase boundary between the $Al_{65}Cu_{20}Fe_{15}$ icosahedral quasicrystal and its high temperature phase was risen with pressure, such as 865 K at 11 GPa, 1402 K at 24 GPa, 1758 K at 33 GPa, 1963 K at 57 GPa, 2050 K at 67 GPa, 2080 K at 104 GPa. In a series of the study, the $Al_{65}Cu_{20}Fe_{15}$ icosahedral quasicrystal was melted completely only when it was heated to 2385 K at 11 GPa. From the present study, it was suggested that mineral icosahedrite ($Al_{63}Cu_{24}Fe_{13}$), the first natural-occurring quasicrystal, was formed at pressure range from 5 GPa to 70 GPa, and at temperature range from 1500 K to 2200 K. This study can be a clue to solve the question of where and how the icosahedrite was formed.

キーワード: $Al_{65}Cu_{20}Fe_{15}$ 正 20 面体準周期結晶, icosahedrite, 安定性, 高温高圧, XRD
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