

Structure and chemistry of dust from laboratory perspective

Chihara H.¹, Takakura T.², Murata K.², Koike C.³, and Tsuchiyama A.⁴

¹ Osaka Sangyo Univ., ² Osaka Univ., ³ Ritsumeikan Univ., ⁴ Kyoto Univ.

From observations, chemical composition of crystalline silicate is known that concentration of Mg is high and Fe is extremely low. On the other hand, from vast studies of meteorites, Mg/Fe ratio of olivine and pyroxene in meteorite is not converged to a certain value. Why observed crystalline silicate shows chemistry of Mg-condensed and Fe-depleted is one of the biggest unsolved problem from early days of astromineralogy. So, we prepared amorphous pyroxene with chondritic Mg/Fe ratio, and then heated it to crystallize. On several steps of crystallization (heating) process, Mg/Fe ratios in crystalline and amorphous phases were analyzed from IR spectroscopy. As a result, we found that Mg is moved into the crystalline phase and Fe is remained in the amorphous phase. This results suggested that crystallization process itself is the origin of fractionation of Mg and Fe in cosmic dust.

Another topic is on anomalous structure of pyroxene crystallized from amorphous phase. We gave this sample the name of HAS (Heated Amorphous Silicate). Well known structures of normal pyroxene are proto-, clino- and ortho-pyroxene. Difference of these structures is originated from the stacking sequence along to a^* -axis. We can identify these structures from the FIR features. However, HAS shows different FIR spectrum from any of these types. And, from the TEM analysis of HAS, we confirmed that the stacking sequence of a^* -axis was disordered. In other words, HAS has a very peculiar structure in which an axis is amorphous and others are crystalline. More interestingly, we found that HAS can fit some spectra of observed AGB stars better than other pyroxenes. FIR observations with Herschel have found the 69 micron feature of forsterite in some objects. However, at this moment, we do not have any positive report which confirmed detections of FIR feature of clino- and ortho-enstatite. This can be explained, if pyroxene grain in space would be crystallized from amorphous phase, and it would have an HAS-like structure.