ESR spectral changes in crystallization of forsterite-composition amorphous materials

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Interstellar silicate dust would be almost completely amorphous (Kemper et al. 2004). Contrary, the existence of crystalline silicate dust like olivine and pyroxene has been revealed in comets and circumstellar environments by infrared spectroscopic observations (e.g. Infrared Space Observatory (ISO) and Subaru Telescope). This crystalline silicate dust is believed to be formed by crystallization of the amorphous silicate dust. Therefore, we have a curiosity of crystallization process and dynamics of such amorphous silicate. Murata et al. (2007) investigated the crystallization of amorphous silicate with chondritic composition quantitatively by infrared spectroscopy, X-ray diffraction (XRD) and electron microscope. In this study, we tested electron spin resonance (ESR) spectroscopy to discuss crystallization of a forsterite-composition amorphous material. In addition, we reported ESR signals of intrinsic defects in forsterite because the related papers have not been reported before.

A forsterite-composition amorphous material, synthesized at Nissin Engineering, was heated at various temperatures (200-1150^{o}C) for durations (1-24 hours). Those samples were irradiated by gamma-rays about 6 kGy and measured by ESR at room temperature. They were measured by XRD as well for a crystallization of forsterite.

The sample heated at 800^{o}C for 1 hour shows clear peaks of forsterite in XRD profile and characteristic ESR signals. Those ESR signals are characterized by crystallization of the amorphous material because of the signals are observed in all the samples which have forsterite peaks in XRD patterns. On the other hand, different ESR signals are observed in the starting material.