Synthesizing of amorphous silicate with mechanochemical method

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Amorphous silicate is a major component of cosmic dust. In astronomy, substances that absorb at around 10 and 20 μm are called astronomical silicates, which are considered as representatives of amorphous silicates in space. But all their physical structure and spectroscopic characteristics have not been studied. In particular, after the ISO era, the research theme of laboratory spectroscopy shifted to crystalline silicate. Then it can be said that research on amorphous has become somewhat inadequate.

There are several ways to make amorphous material in the laboratory. The most representative method is to heat the material into a melt and then quench it. However, there are difficulties in the need of an experimental furnace capable of producing high temperatures of 1600-1800 °C. And producing of a sufficiently rapid cooling rate in the laboratory is also very difficult. A sol-gel method, which applies a liquid reaction, is also often used. This is a method of producing an amorphous materials by hydrolysis and polymerization reaction at a relatively low temperature using an agent called TEOS(Tetraethyl Orthosilicate) containing tetrahedron of SiO_4 and an alkoxide containing metal cations. Industrially, it is a mature method and is widely used as a method for producing functional glass materials. Furthermore, there is also a method of creating defects in the crystal structure by colliding relatively heavy particle beams with the crystal. In any case, there are not many ways to easily produce amorphous material. As far as we know, the absorption spectra of amorphous silicates prepared by various methods so far are certainly close to the astronomical silicates, but there is no positive report that they completely coincide.

In this study, we attempted to synthesize amorphous materials using a "Mechanochemical method" that promotes material formation by mechanically impacting and using the kinetic energy generated thereby as the energy of chemical reactions. A planetary ball mill was used to react of SiO_2 and MgO or $Mg(OH)_2$. It seems to have succeeded in synthesizing an amorphous material. The generated amorphous material is examined by XRD and IR spectroscopies, and the features of each spectrum are reported.