10 micron silicate feature toward Herbig Ae/Be stars observed with Subaru/COMICS

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Silicate dust grains are as abundant in space as carbonaceous dust grains. They are frequently detected in spectra toward interstellar clouds, late type stars, and young stellar objects. Silicate features are observed as emission toward many late type stars and as absorption through interstellar matter and toward protostars. They usually have two broad features at 9.7 and 18 micron, which are interpreted as the features of amorphous silicate grains. In contrast, some comets in our solar system show not only the amorphous silicate emission but also a 11.2 micron peak due to crystalline olivine in their spectra. Short Wavelength Spectrometer (SWS) on board Infrared Space Observatory (ISO) detected multiple band emissions due to crystalline forsterite toward C/1995 O1 (Hale-Bopp) in 20-40 micron (Crovisier et al. 1996).

For young stellar objects, past observations only detected amorphous silicate emission/absorption toward Herbig Ae/Be stars and T Tauri stars in the 10 micron region (e.g. Hanner et al. 1998, ApJ, 502, 871). However, Knacke et al. 1993 (ApJ, 418, 440) detected the crystalline olivine feature at 11.2 micron toward beta Pic, which is a Vega-like star where the central star already reached the main sequence although, a main sequence star with a debris dust disk around. Thus the crystalization of silicate dust grains should have a key link to the planetary system formation/evolution during the evolution from YSOs to the main sequence stars.

Recently, ISO/SWS detected many features very similar to the spectra of comet Hale-Bopp toward Herbig Be star HD100546, which are due to crystalline forsterite (Malfait et al. 1998, A&A, 332, L25). Our group detected for the first time the crystalline silicate feature toward T Tauri star Hen3-600A, which has a mass similar to our sun (Honda et al. 2003, ApJ, 585, L59). Recent observations of late type stars also show that some of the stars exhibit crystalline silicate features. However, no crystalline features have been detected toward protostars yet. It probably suggests that the crystalline silicate grains found toward YSOs are related with some kinds of crystalization processes during the evolution of circumstellar disks.

We made observations to obtain 10 micron spectra of Herbig Ae/Be stars with a better spectral resolution (about 250) and a better S/N ratio than the past observations using the Cooled Mid-Infrared Camera and Spectrometer (COMICS) on the 8.2m Subaru Telescope. The observations of silicate spectra toward young stars is a key project of the COMICS group and is going on from the first light of the COMICS. In December 2001, we made this kind of observations toward six Herbig Ae/Be stars: HD36112 (A5IVe, 200pc), V380 Ori (A1e), RR Tau (A4e), VY Mon (B8e, 900pc), LkHa208 (A3e), and LkHa25 (B7e). Age of the targets are estimated as 1Myr, 1Myr, 0.1Myr, 0.05Myr, 1Myr, and 0.2Myr, respectively. Among their 10 micron band spectra, VY Mon shows no particular features, but the other five objects all show some features. Especially, HD36112, V380 Ori, LkHa208, and LkHa25 show a broad emission feature with peak around 9.7 micron, which is due to amorphous silicate grains. These four targets also have emission features around 11.2 micron, which cannot be exlained by amorphous silicate grains. Though the wavelength corresponds to the feature due to crystalline olivine grains, it may be due to polycyclic aromatic hydrocarbon (PAH) dust grains since some objects have broad features around 8.6 micron.

In this presentation, we show the spectra of the six objects and discuss results of dust composition fitting to the spectra to estimate the origin of the observed features.