N91-14991

STEPS TOWARD INTERSTELLAR SILICATE DUST MINERALOGY

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One of the most certain facts on interstellar dust is that it contains grains with silicon oxygen tetrahedra (SOT), the internal vibrations of which cause the well known silicate bands at 10 and 18 μm. The broad and almost structureless appearance of them demonstrates lacking translation symmetry in these solids that must be considered amorphous or glassy silicates. There is no direct information on the cations in these interstellar silicates and on the number of bridging oxygens per tetrahedron (NBO). Comparing experimental results gained on amorphous silicates, e.g. silicate glasses, of cosmically most abundant metals (Mg, Fe, Ca, Al) with the observations is the only way to investigate interstellar silicate dust mineralogy (cf. Dorschner and Henning, 1986).

At Jena University Observatory IR spectra of submicrometer-sized grains of pyroxene glasses (SSG) have been studied. Pyroxenes are common minerals in asteroids, meteorites, interplanetary, and supposedly also cometary dust particles. Generally, primitive solar system solids can serve as a guide to interstellar dust mineralogy (Dorschner, 1968, Jones and Williams, 1987). Pyroxenes consist of linearly connected SOT (NBO=2). In the vitreous state reached by quenching melted minerals the SOT remain nearly undistorted (Si-O bond length unchanged); the Si-O-Si angles at the bridging oxygens of pyroxenes, however, scatter statistically. Therefore, the original cation oxygen symmetry of the crystal (octahedral and hexahedral coordination by O) is completely lost. The blended bands at 10 and 18 μm lose their diagnostic differences and become broad and structureless. This illustrates best the basic problem of interstellar silicate mineral diagnostics.

Optical data of glasses of enstatite (E, $Mg_2Si_2O_6$), bronzite (B, $(Mg,Fe)_2Si_2O_6$), hypersthene (H, same formula as B, but higher Fe content), diopside (D, $CaMgSi_2O_6$), salite (S, $Ca(Mg,Fe)Si_2O_6$), and hedenbergite (HB, $CaFeSi_2O_6$) have been derived. Results of E, B (Dorschner et al., 1986, 1988), and H show very good agreement with the observed silicate features in the IR spectra of evolutionarily young objects that show "P-type" silicate signature according to the classification by Gürtler and Henning (1986). Table 1 shows compositional parameters and main characteristics of experimental SSG spectra in IR for the glasses E, B, and H. Our results fit excellently the relations derived by Koike and Hasegawa (1987) and suggest that the band ratio of the "astronomical silicate" by Draine and Lee (1984) is too low.

Table 1: Composition and spectral characteristics of pyroxene glass SSG

Parameter		E	B	H
SiO_2 content	%	57.7	56.0	52.3
MgO content	%	35.2	33.4	22.8
FeO content	%	2.7	6.6	19.8
λ(10)/FWHM(10)	μm	9.4/2.4	9.5/2.5	9.5/2.8
MAC(10)	$cm^2 g^{-1}$	3000	3000	2430
λ(18)/FWHM(18)	μm	18.5/9.6	18.5/9.5	18.5/8.4
MAC(18)/MAC(10)		0.47	0.55	0.58

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