Condensation studies in the Fe-Mg-MgO-SiO system.

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Introduction: The various Fe-Mg silicates are among the most abundant minerals in space. Their chemical composition and atomic short and long range order inform not only on the relative abundance of the respective elements but also on the formation conditions like gas pressure and temperature, respectively.

Infrared (IR) spectral information obtained from the various space observations (ISO [1], Spitzer [2] and MIDI [3]) is usually analysed by comparison to spectral calculations based on optical data for well defined silicates, silicon oxides, etc. However, there are at least two problems: First, the database does not contain all kinds of possible systems and second, depending on the nature of the mixture, simulation of spectra with data for bulk material may be wrong.

In our condensation experiments we address deeper understanding of the basic physics of respective IR spectral changes, especially effects related to elemental Fe particles in silicates and we therefore intend to perform *in-situ* IR spectroscopy during formation and further solid-phase reaction processes in layers made by co-evaporation of Fe, Mg, MgO, and SiO under well-defined pressure and temperature conditions. The obtained data will be used for improvement of spectral modelling, for instance of the mass extinction of dust which is a central quantity in radiation transport.

Experimental Setup: The experimental setup consists of an ultra high vacuum chamber (base pressure < $1x10^{-10}$ mbar) equipped with one evaporator, a sample holder and a quartz micro balance for thickness measurements. A Fourier transform IR spectrometer (Bruker Tensor 27) is attached to the system which allows a direct monitoring, i.e., *in-situ*, of the condensation process on an appropriate sutstrate.

First results and discussion: The first *in-situ* experiments were performed with silicon oxides (SiO_2, SiO). We were able to follow the development of vibrational features with thickness, which is shown in Fig. 1.

The uppermost spectra correspond to 0 nm. Between two successive spectra 6.7 nm were evaporated with a final film thickness of approximately 100 nm. Comparing both series of spectra it becomes obvious that thermal SiO_2 evaporation gives condensed silicon monoxide (and gaseous oxygen) [5]. The SiO transversal optical frequencies obtained in a dielectric function fit are marked.

From such studies it follows that above 1 nm thickness SiO already shows bulk-like vibrations [4] and can be described by a dielectric function model [5].

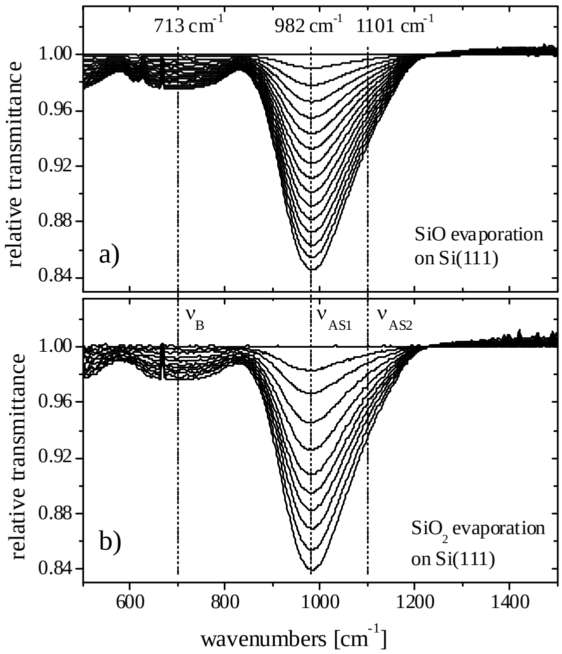

Figure 1: Selected normal transmittance IR spectra measured during condensation of thermally evaporated SiO (a) and SiO_2 (b) on Si(111) at 300 K under UHV conditions, respectively.

Future work: Systematic condensation studies in the Fe-Mg-MgO-SiO system are planned. These will be realized by an additional evaporator which makes the co-evaporation of up to 4 materials possible (together with the existing evaporator).

References:

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