Laboratory Experiments on the Kinetics of Thermal Annealing of Dust in Proto-Planetary Disks

Reinhard, Bianca[1] Lattard, Dominique[1] Burchard, Michael[1] Dohmen, Ralf[2] Klevenz, Markus[3] Trieloff, Mario[1] Pucci, Annemarie[3]

[1]Institut für Geowissenschaften, Ruprecht-Karls-Universität Heidelberg, Im Neuenheimer Feld 236,069120 Heidelberg
[2]Institut für Geologie, Mineralogie und Geophysik, Ruhr-Universität Bochum, Universitätsstr. 150, 44780 Bochum
[3]Kirchhoff Institut für Physik, Universität Heidelberg, Im Neuenheimer Feld 227, 69120 Heidelberg

Since the ISO (Infrared Space Observatory) mission we know that interstellar dust particles are partly crystalline. One of the main processes leading to the crystallisation of amorphous cosmic dust is thermal annealing (e.g. Gail 2001). In this project we investigate the kinetics of the crystallisation process by measuring the time scale for different dust compositions, in particular those of olivine, ortho- and clinopyroxene. This data is needed for a consistent astrophysical modelling of the radial abundances of dust and of its chemical composition at various evolutionary stages.

Different experimental sequences, not comparable starting materials (e.g. gels and smokes), chemical inhomogenities and inclusions of crystal seeds led to contradictory results in previous studies (e.g. Fabian et al. 2000; Hallenbeck et al. 1998; Jäger et al. 2003; Kaito et al. 2006; Rietmeijer et al. 2002; Thompson et al. 2002). There were also vast discrepancies in the definition of the degree of crystallinity.

We have embarked on a new strategy by using amorphous thin films deposited on a germanium-wafer via PLD (Pulsed Laser Deposition). With this method we obtain a chemically well-defined amorphous thin film of stoichiometric composition with a constant and accurate adjustable thickness (Dohmen et al. 2002). We have developed a simple annealing sequence in an upright furnace, with short heating periods and the possibility to quench the sample. Before and after annealing the sample is characterized not only by IR spectroscopy but also by AFM (Atomic Force Microscopy) and SEM (Scanning Electron Microscopy) analysis.

We combine multiple methods for the characterization of the samples in order to improve the definition of the degree of crystallinity and then relate them to astronomical data.

The IR spectra of the first annealed samples on the Mg_2SiO_4 composition showed the development of characteristic forsterite peaks. Observation with SEM and AFM revealed a dewetting of the thin film from the surface of the carrier material.

Experimental series with different annealing times and temperatures are on the way.

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References:

Dohmen R, Becker H-W, Meißner E, Etzel T, Chakraborty S (2002) Eur J Mineral 14: 1155-1168

Fabian D, Jäger C, Henning T, Dorschner J, Mutschke H (2000) Astron Astrophys 364: 282-292

Gail (2001) Astron Astrophys 378: 192-213

Hallenbeck SL, Nuth III JA, Daukantas PL (1998) Icarus 131: 198-209

Jäger C, Dorschner J, Mutschke H, Posch T, Henning T (2003) Astron Astrophys 408: 193-204

Kaito C, Sasaki S, Miyazaki Y, Kurumada M, Kumamoto A, Suzuki H, Kimura Y, Koike C (2006) 69^{th} Annual Meteoritical Society Meeting

RietmeijerFrans J. M. Rietmeijer

Hallenbeck SL, Nuth III JA, Karner JM (2002) Icarus 156: 269-286

Thompson SP, Fonti S, Verrienti C, Blanco A, Orofino V, Tang CC (2002) Astron Astrophys 395: 705-717

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