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FT-IR spectroscopy of fine-grained planetary materials

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FT-IR SPECTROSCOPY OF FINE-GRAINED PLANETARY MATERIALS. A. Morlok, G. C. Jones, Monica M. Grady, Department of Mineralogy, The Natural History Museum, Cromwell Road, London SW7 5BD, UK. e-mail A.Morlok@nhm.ac.uk

Introduction: Dust is the basic building block of all larger bodies formed in the Solar System: planets, their satellites, comets and asteroids. Some of these dust grains have survived 4.56 Gyr of processing, and occur as interplanetary dust particles (IDPs), GEMS (Glass with embedded sulphides) within IDPs and presolar grains in meteorites. Primitive meteorites can also be regarded as aggregations of relatively unprocessed dust. Dust particles from these sources are analyzed in laboratories by planetary scientists; most of the presolar grains are carbonaceous (SiC, graphite, diamond), and only few interstellar silicates have been measured [1].

A complementary source of information about dust comes from a different scientific community, and is obtained by astronomical observations from both ground- and space-based observatories of dust in a variety of astrophysical environments. In this case, IR spectra provide information e.g. about mineral composition and structure of the dust particles, which have mainly been identified as silicates.

In order to relate direct and astronomical measurements of dust grains, IR spectra of ‘pure’ minerals are required. So far, mainly amorphous glasses [e.g. 2] or fine grained smokes [3] have been used as standard materials, rather than natural minerals. These studies also mostly concentrated on pure end members, which are rare in nature. Minerals from meteorites are probably a better comparison for the astronomical analyses, since they formed in a similar environment to the dust grains. The aim of this project is to provide a database of infrared and optical spectra of well characterized minerals from representative meteorites, to assist with more detailed characterization of astrophysical dust.

Techniques: IR spectra will be obtained with a Perkin Elmer Spectrum One FT-IR microscope over a wavelength range of ~ 2.5 to 25 μm . The specimens will be characterized by electron beam methods and X-ray diffraction. Unpolished grains hand-picked from meteorites will be analysed, the original morphology taken as a possible approximation for unprocessed dust grains in space. Following this, polished samples will be analysed for high-quality spectra. We intend to apply several FT-IR spectroscopy techniques: specular reflectance, diffuse reflectance, transmission and ATR.

Results: Fig.1 shows a set of diffuse reflectance spectra obtained from powdered olivine grains from terrestrial standards, Fig.2 olivines from terrestrial and meteoritic sources, over a range of forsterite compositions. The terrestrial olivines are pure crystalline mineral standards (not glasses). The meteoritic olivine is from the Admire pallasite, and has a composition of Fo_{88} [4]. In each case, powdered mineral samples were mounted on an abrasive stick and analysed by diffuse reflectance IR spectroscopy.

Similar techniques will be used in the first phase of the project for analyses of randomly oriented meteorite grains in various size fractions. In our preliminary study, we plan to present data on minerals from several type 3 ordinary chondrites (Parnallee LL3.6, Khohar L3.6, Brownfield H3.7).

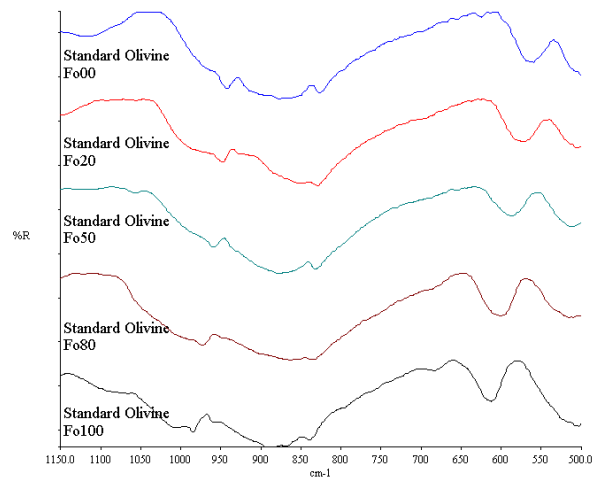


Fig.1: Diffuse reflectance FT-IR spectra of terrestrial standard olivines with a range of composition from Fo_{00} to Fo_{100} (in % reflectance).

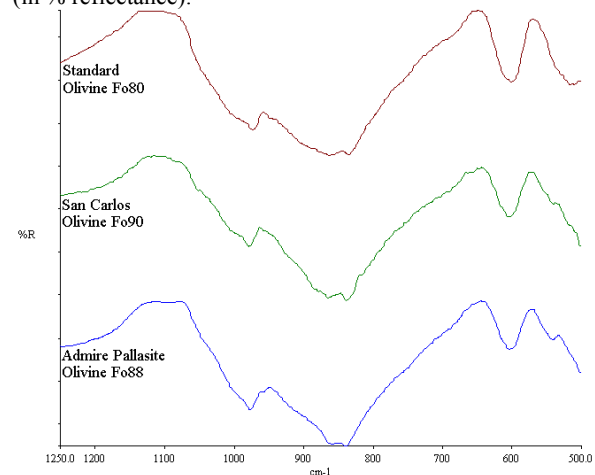


Fig.2: Diffuse reflectance FT-IR spectra of olivines from the Admire pallasite (Fo_{88}) [4], terrestrial San Carlos olivine (Fo_{90}) [5] (in % reflectance)

References: [1] Messenger et al. (2003) *Science* 5616, 105-108; [2] Jaeger C. et al. (1994) *Astronom. & Astrophys.* 292, 641-655; [3] Nuth J. A. III (1996) In: *Proc. NATO ASI on the Cosmic Dust Connection* (ed. J.M. Greenberg), Kluwer, Netherlands, 205-221; [4] Buseck P. R. and Goldstein J. I. (1969) *Bull. Geol. Soc. Amer.* 80, 2141.; [5] Lemelle L. et al. (2001) *The American Mineralogist*, Vol. 86, 47-54