Mid-Infrared Spectroscopy of CAI and AOA from the Allende CV3.2 Chondrite. A. Morlok[1,4], O.N. Menzies[2,4], M. Koehler[3,4], P. Bland[2,4], G. Cressey[1], M.M. Grady[1,4] [1]The Natural History Museum, Cromwell Road, London, SW7 5BD, UK, A.Morlok@nhm.ac.uk , [2]Imperial College London, South Kensington Campus, SW7 2AZ. [3]Institut fuer Planetologie, Wilhelm-Klemm-Str.10, 48149 Muenster, Germany [4]IARC

Introduction: Infrared spectroscopy of dust grains in circumstellar debris disks is the main way to obtain information about the mineralogical composition of such material. To find out what these spectra actually mean, infrared spectra of standard materials are needed for comparison. While so far mainly synthetic or terrestrial minerals have been used for this purpose, we use mineral separates or components from primitive meteorite for this purpose. This is based on the assumption, that these phases formed in environments similar to those where the astronomical spectra originate. Like meteorites, the astronomical dust is often not completely pristine, but represents a later generation of processed material [1].

In the first part of our project, we analysed olivines and pyroxenes from unequilibrated chondrites [2,3]. Following this, we turned to Calcium-Aluminium-Rich inclusions (CAI) and Amoeboid Olivine Aggregates (AOA). These bodies represent the first step in condensation and processing of minerals in the Solar System. Here we present further results of the spectroscopy of these objects.

Techniques and Samples: We used bulk material of 3 powdered CAIs and one AOA from Allende.

Mineralogy: The mineralogical composition of this material was previously measured using a new micro-XRD technique [4]. With the help of this technique, it is possible to quantify the modal mineralogical composition of small amounts of material. CAI 15 has been identified as a compact, type A inclusion. Its composition is 77wt% gehlenite, 16wt% grossular and 7 wt% spinel. CAI 5 is a compact, type A CAI. The modal mineral abundance in the fine-grained, spinel rich CAI 2 is 47wt% anorthite, 12wt% diopside, 18wt% hedenbergite and 23wt% spinel. The composition of the AOA 3 is 5wt % akermanite, 19wt% $forsterite_{100}$, 25wt% $forsterite_{90}$, 30wt% $forsterite_{80}$ and 21wt% hedenbergite. Also some matrix areas have been analysed to get information about potential contamination with that material.

Infrared Spectroscopy: The infrared spectra of the specimens were obtained using a Perkin Elmer Auto Image infrared microscope. Small amounts of powdered CAI material were further compressed to a very fine grained powder using a diamond compression cell first, and then analysed under the infrared microscope. Of several measurements of the material, an average spectrum was calculated [5]. The results are presented in Fig.1.

The astronomical spectra used for comparison in Fig.1 were taken using Earth and space based telescopes. These were the NASA Aerospace spectrograph at the NASA Infrared Telescope Facility (IRTF) for the circumstellar dsk around β Pictoris [6], Aerospace Corp BASS (IRTF)for the res supergiant PR Per [7], the ISOCAM at the Infrared Space Observatory (ISO) for Zodiacal dust [8] and the United Kingdom Infrared Telescope (UKIRT) for comet C/2002 V1 NEAT [9].

Discussion: Small shifts of ~0.1 micron provided, comparison with a spectra of the circumstellar disc of β Pictoris [6] shows good similarity with CAI 2 for the strong bands(Fig.1a), as well as with the matrix material. The only fit for some strong bands with the red supergiant PR Per [7] would be possible with a ~0.2 micron shift of CAI 2 (Fig.1b). Strong bands in matrix material and in CAI 2 and AOA 3 agree very well with bands of the Zodiacal light [8] (Fig.1c). Given a minor shift of ~0.2 micron, inclusion AOA 3 and CAI 5 also fit well. The spectra of comet C/2002 V1 NEAT [9] had no similarity with the laboratory spectra.Small shifts in bands composition can be accomplished in several ways: temperature effects, compositional (chemical and isotopic) differences, grain size and morphology. However, since these comparisons only take into account a narrow region in the mid-infrared, the findings have to be first confirmed by measurements over a wider range. For most minerals, many characteristic bands occur in the far infrared (up to ~100 micron). Also in no case could all bands in the astronomical spectra be confirmed with one of our laboratory spectra, which indicates that at least another component is missing.

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References:

[1] Okamoto Y.K. Kataza H. and Honda M. et al. (2004) *Nature, 431*, 660–663. [2] Morlok A. Koehler M. Menzies O.N. et al. (2004) Workshop Chondrites and the Protoplanetary Disk, Kauai, #9022 [3] Morlok A. Koehler M. Menzies O.N. et al. (2004) Workshop Chondrites and the Protoplanetary Disk, Kauai, #9023 [4] Menzies O.N. Bland P.A. Cressey G. et al. (2004) *MAPS 39, A67* [5] Morlok A. Koehler M. Bowey J. et al. (2005) *Mon. Not. Roy. Astr. Soc.* (Submitted) [6] . Knacke R. et al. (1993) *Astrophys. Jour. 418*, 440 [7] Speck A.M. et al. (2000) *A&A 146*, 437-464 [8] Hanner M. et al. (1997) *Earth, Moon and Planets 79*, 247 [9] Reach W. et al. (2003) *Icarus 164*, 384

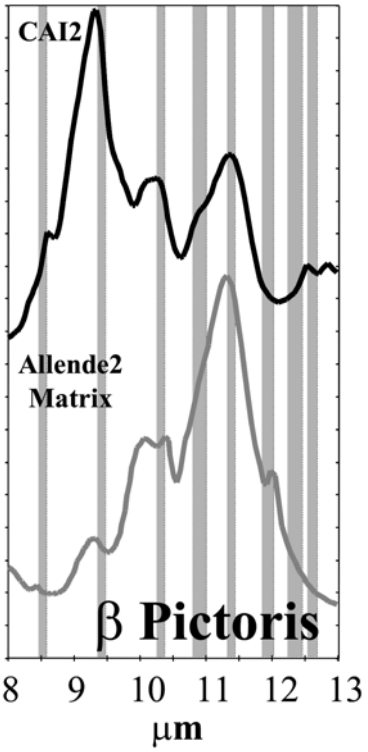


Fig.1a

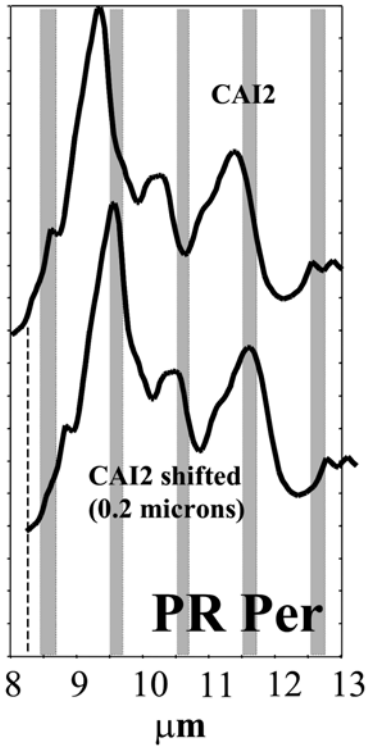


Fig.1b

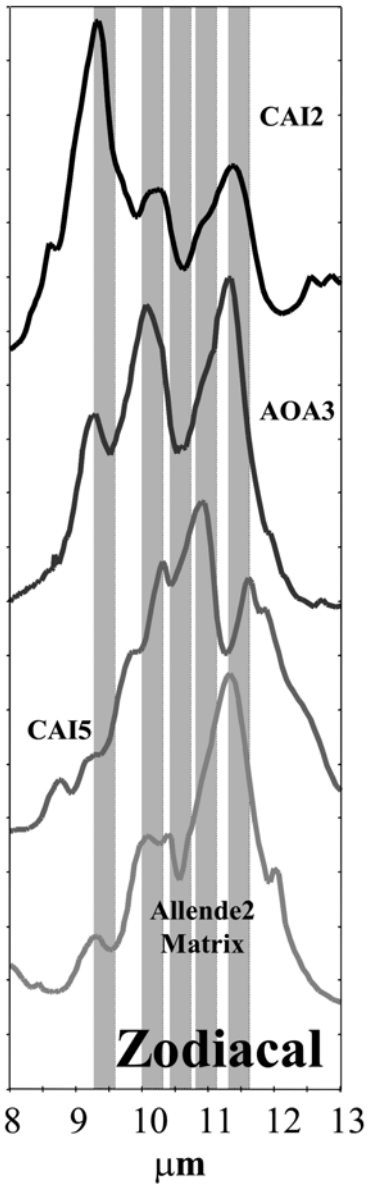


Fig.1c

Fig.1a-c: (All spectra in relative absorbance) Comparison of laboratory spectra with the bands of astronomical spectra (grey bands). (a) comparison with the circumstellar disk of β Pictoris, (b) with the red supergiant PR Per and (c) with that of Zodical dust.