Doing Astrophysics in the TEM

Alexander, Conel[1]
[1]DTM, Carnegie Institution of Washington, 5241 Broad Branch Road, Washington DC 20015, USA

Chondritic meteorites and interplanetary dust particles contain material that formed in the winds of dying stars, in the interstellar medium and in the early Solar System. This material ranges in size from a few nanometers to microns. A combination of new and established microanalytical techniques means that we can now do astronomy and astrophysics in the laboratory!

Dust in the interstellar medium (ISM) begins its life in the circumstellar winds of dying stars, such as red giants and asymptotic giants and supernovae. Dust that forms in these environments will inherit large, distinctive isotope anomalies associated with the particular nucleosynthesis that occurs in these stars. From IR observations, the types of dust thought to form around these stars include: SiC, poorly graphitized C, corundum, spinel and silicates. The silicates are thought to be mostly amorphous, with 10-30% forsterite and enstatite.

Once in the interstellar medium, grains are subject to destruction mostly in 50-200 km/s supernova-generated shock waves. Silicates in particular are subject to amorphisation by the fast moving atoms/ions in the shocks and in cosmic rays. The very low degree of crystallinity in the ISM ($1\pm1\%$) suggests that amorphisation occurs within 1-2% of a grain's lifetime. Experiments suggest that ISM silicate grains should be porous, non-stoichiometric and reduced due to preferential sputtering of O and Mg relative to Si.

A recent development that has created much interest amongst astronomers is that dust at the surfaces of protoplanetary disks are much more crystalline than dust in the ISM. There also seems to be a radial gradient in crystallinity and composition in the dust. There are several ideas for how this 'annealing' comes about, including circulation of dust through the hot inner disk and shock wave heating in situ.

The challenge of finding circumstellar grains in meteorites is that they are in a sea of Solar System material. To date the types of grain that have been found include SiC (1-20 ppm), Si_3N_4 (1-10 ppb), Al_2O_3 and spinel (1-50 ppm), poorly graphitised C (1ppm), nanodiamonds (100-1400 ppm), and silicates (100-1000 ppm). Most techniques for finding the circumstellar grains utilize the high spatial resolution and automation of modern ion microprobes (100nm-1μm) to search for grains with large isotopic anomalies. Most materials are fairly chemically robust, and were first found by acid digestion of $>$99% of the material. This could not be done for silicates, but recently several groups have found circumstellar silicates in situ in meteorites and IDPs. SiC has been found in situ using SEM X-ray mapping techniques. Once located, the grains can be studied in detail using a range of micro-analytic techniques, most notably TEM, to test astrophysical models of grain condensation and growth, and of processing in the ISM and early solar nebula. Reassuringly, the grains differ from the observations and predictions in several important respects.

Friday 6$^{\text{th}}$ January. Session x, xx am

Oral

→

Abs. No. **189**
Meeting: **DMG 2008**
submitted by: **Alexander, Conel**
email: **alexande@dtm.ciw.edu**
date: **2008-05-30**
Req. presentation: **Vortrag**
Req. session: **S02**