OBSERVATIONAL EVIDENCE FOR PRESOLAR GRAINS AROUND OXYGEN-RICH EVOLVED STARS.

A. K. Speck[1], A. M. Hofmeister[2], M. J. Barlow[3], and R. J. Sylvester[3], [1]Astronomy Department, University of Illinois, Urbana IL 61801, USA (akspeck@astro.uiuc.edu), [2]Department of Earth and Planetary Science, Washington University, St. Louis MO 63130, USA, [3]Physics and Astronomy Department, University College London, London, WC1N 1AS, UK.

Many presolar grain types have been found in meteorites since the discovery of presolar silicon carbide (SiC) grains in the Murray meteorite [1]. Initially these were mostly limited to C-rich grains. However, more recently, O-rich presolar grains have been isolated [e.g., 2, 3], e.g., corundum (Al_2O_3), spinel ($MgAl_2O_4$), hibonite ($CaAl_{12}O_{19}$), and rutile (TiO_2). The majority of these O-rich grains, like the SiC grains, have isotopic compositions indicative of formation around asymptotic giant branch (AGB) stars [2,3].

Theoretical dust condensation models for O-rich AGB stars include the formation of Al_2O_3 [e.g., 4] and TiO_2 [5], usually as condensation nuclei for the more abundant silicates. However, there is not much observational evidence for most of these presolar grains around AGB stars, and what little evidence does exist is generally misinterpreted. The dominant minerals observed around AGB stars are the silicates, presolar examples of which are not found in meteorites, although this may be due to the laboratory processing used to extract the grains. There is evidence for presolar silicates in the solar system found in interplanetary dust particles (e.g., GEMS) [6].

In order to study the mineralogy of dust around AGB stars we observe their infrared (IR) spectra and compare these to laboratory spectra of likely minerals. This technique must be practiced with caution to avoid incorrect attributions of spectral features to certain minerals (e.g., SiC; see discussion in [7]). Until recently, a feature in the spectra of some AGB stars at ~12.5–13.0 µm was attributed to Al_2O_3 [e.g., 8]. It has recently been shown that this is unlikely [e.g., 9], since for most polytypes the spectral features of Al_2O_3 are both the wrong shape and peak at the wrong wavelength. There is one polytype of Al_2O_3 with a peak in the right range, however, this is accompanied by a feature at 21 µm that is not seen in the observed spectra. Furthermore, the ~13-µm feature is not ubiquitous in AGB star spectra, which would be odd if it were due to a mineral as important as Al_2O_3 in the expected dust condensation sequence. We present observational evidence for Al_2O_3 in the mid-IR spectra of O-rich AGB stars and red supe rgiants, demonstrating that this mineral is indeed present in observable abundance around many of these stars.

Another presolar grain has also been suggested as the carrier of the ~13-µm feature: spinel [10]. However, this too is erroneous. The IR spectrum of spinel is very sensitive to level of order/disorder in the crystal structure of the sample [11]. The optical data used to justify this attribution was compromised as it is a compilation of data from samples of differing levels of disorder [12]. Previously published optical data for crystalline spinel [e.g., 13,14] suggests that the spectral feature peaks longward of 13.5 µm and is therefore unlikely to be responsible for the observed ~13-µm feature. Infrared spectra of single samples of spinel at various levels of crystallinity/ amorphousness are needed to clarify whether we see any evidence for spinel in the observed IR spectra.

To date, the remaining minerals have not been investigated observationally. In the case of rutile, this is due to abundance of Ti, which makes it unlikely that an observable amount of TiO_2 is produced. The most recently discovered O-rich presolar is hibonite, which is currently under investigation. It is possible that the IR features of hibonite appear in some ISO spectra (see, e.g., spectrumin [15]) that are presented here. At present, the only O-rich presolar grain type for which there is observational evidence is Al_2O_3. In order to progress further in matching these presolar grains and the grains currently forming around AGB stars we need to know more details about these grains, e.g., polytypes, the level of crystallinity/amorphousness in the grains, size distributions, etc. With this information we can better constrain the IR spectral feature we should be looking for.

References: [1] Bernatowicz T. et al. (1987) *Nature, 330,* 728. [2] Nittler L. R. et al. (1997) *Astrophys. J., 483,* 475. [3] Choi B.-G. et al. (1999) *Astrophys. J. Lett., 522,* 133. [4] Sedlmayr E. (1989) *IAU Symposium 135,* 467. [5] Jeong K. S. et al. (1999) *IAU Symposium 191,* 233. [6] Bradley J. et al. (1999) *Science, 285,* 1716. [7] Speck A. K. et al. (1999) *Astrophys. J. Lett., 513,* 87. [8] Vardya M. S. et al. (1986) *Astrophys. J. Lett., 304,* 29. [9] Begemann B. et al. (1997) *Astrophys. J., 476,* 199. [10] Posch T. et al. (1999) *Astron. Astrophys., 352,* 609. [11] Andreozzi G. et al. (2000) *Am. Mineral.,* in press. [12] Tropf W. J. and Thomas M. E. (1991) in *Handbook of Optical Constants,* p. 883. [13] Preudhomme J. and Tarte P. (1971) *Spectrochim. Acta, 27A,* 1817. [14] Chopelas A. and Hofmeister A. M. (1991) *Phys. Chem. Mineral., 18,* 279. [15] Hrivnak B. et al. (2000) *Astrophys. J.,* in press.