ATYPICAL MAGNESIUM ABUNDANCES IN OXYGEN-RICH STARDUST: NANOSIMS AND AUGER ANALYSES.

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Introduction: Astronomical observations indicate that silicates are the major dust component of O-rich red giant stars. The Mg/Si and Mg/Fe abundance ratios in these circumstellar shells are of particular interest, as they strongly influence the types of dust to condense [1]. These data can be tested on Earth by high precision laboratory analyses of presolar silicates found within primitive Solar System materials [2]. Auger spectroscopy is a powerful tool to study the chemistry of these stardust grains on a <30 nm scale. It has been used to analyze rare presolar grain types [3] and also allows characterization of composite phases [4]. Here we report on results from combined NanoSIMS/Auger measurements on O-rich stardust from the Acfer 094 meteorite.

Methods: Presolar silicates/oxides were identified by NanoSIMS O isotope mapping at the MPI for Chemistry [5]. Auger analyses of selected grains were performed with the St. Louis Scanning Auger Nanoprobe using a 10 kV/ 0.3-1 nA beam.

Results and discussion: Four of 29 analyzed grains belong to Group II ($^{18}O/^{16}O<1x10^{-3}$), indicative of lower-than-solar metallicity or cool bottom processing in red giant stars. Two of these are Al oxides with low Mg contents (Al_2O_3 or hibonite) and one is a highly Si enriched glass, possibly SiO_2. Recent studies by NanoSIMS/TEM also revealed two presolar silicates with low $^{18}O/^{16}O$ ratios and low Mg contents [6,7]. Astrophysical observations indicate that stars of very low metallicities (<0.01x solar) have low Mg/Si ratios [1], which may thus be alternative stellar sources of the grains described here. However, the $^{18}O/^{16}O$ ratios of the grains are still too high to support this scenario, and it is questionable whether dust grains can form under such low metallicity conditions at all. One grain of particular interest has an unusually high Mg abundance and O/Si ratio (58.7% O, 31.9% Mg, 9.4% Si), and is not compatible with any standard silicate. Two presolar grains of similar composition have been detected recently in the CR chondrites QUE 99177 and MET 00426 [8, unpublished data]. These chemically similar phases therefore represent a new type of Mg-rich stardust, although their isotope characteristics (two Group I grains of different $^{17}O/^{16}O$ ratios, one Group IV grain) point to unrelated origins. Under non-equilibrium conditions MgO is expected to condense around stars with low mass loss rates ($<4x10^{-6}\ M_{\odot}a^{-1}$) and Mg/Si>2 [1,9]. The grains` compositions are clearly not compatible with pure MgO, but our discoveries emphasize that condensation of highly MgO enriched dust as predicted by theory [9] is possible in circumstellar shells. The MgO-rich grain from Acfer 094 also exhibits a rim of Fe-rich oxide, which is clearly also anomalous in oxygen. If this rim condensed at lower temperatures onto the Mg-rich grain, this supports the non-equilibrium formation scenario [e.g. 3].

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