DETERMINING TRACE ELEMENT ABUNDANCES IN SINGLE PRESOLAR SiC GRAINS

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Motivation: Presolar SiC grains have been well characterized according to their isotopic compositions, providing details of the nucleosynthetic processes that take place in carbon-rich stars and supernovae. In addition, the abundances of trace elements in presolar SiC grains are also likely to be directly related to both nucleosynthesis and the condensation environment of the parent stars. Most studies of presolar SiC grains have been performed using secondary ion mass spectrometry (SIMS). However, this technique is destructive and suffers from matrix effects and a lack of suitable SiC standards, such that there have been few studies combining isotopic compositions and trace element abundances within individual presolar SiC grains [1].

Synchrotron X-ray fluorescence (SXRF), for which matrix effects are well understood and easily corrected for, has been successfully used to detect a wide range of trace elements in presolar SiC grains [2, 3]. Also, as SXRF is nondestructive, the same grains can then be investigated with other analytical techniques. However, in the earlier SXRF studies, the isotopic compositions of the grains were never measured due to technical difficulties in the design of the sample mount. We have now begun a combined trace element and isotopic study of individual presolar SiC grains.

Experimental: Presolar SiC grains from the KJG size fraction (1.5–3 µm) [4] will be deposited upon CVD diamond films. Previously, Kapton and SiN have been used as the mounting substrate but these were found to be fragile, made locating grains difficult, and in the latter case, prevented the use of Si as the reference element [2, 3]. The diamond films will initially be examined using a scanning electron microscope (SEM) in order to identify and map the SiC grains, with the same grains relocated at the Advanced Photon Source (APS) using a reflected light microscope. SXRF analyses will then be made using the GeoSoilEnviroCARS beam-line 13-IDE. This beam-line can provide a spot size of ~2 µm, suitable for measurements of individual SiC grains. A beam energy of ~22.5 keV should be sufficient for fluorescence of many elements known to be present at ppm levels. Spectra will be calibrated using two NIST reference materials and background corrections made by measuring the substrate.

Summary: We will report trace element abundance data for ~15 presolar SiC grains. The sample mount is designed so that the isotopic compositions of the same grains can then be analyzed using SIMS and newly developed instruments such as CHILI [5].

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