A HIGH SENSITIVITY, HIGH SPATIAL RESOLUTION TOF-SIMS INSTRUMENT WITH LASER PHOTOIONIZATION FOR THE STUDY OF INTERSTELLAR GRAINS J M Tizard, I C Lyon and T. Henkel. Department of Earth Sciences, The University of Manchester, Manchester M13 9PL, UK (Julia@unsgac.org, Ian.Lyon@man.ac.uk, Torsten.Henkel@man.ac.uk)

Introduction:

Interstellar grains separated from meteorites have been studied using ion probes for over a decade and many measurements of isotope ratios of major abundance elements (Si, C, O, Mg, N) for micron sized, or larger, grains have been published [e.g. 1 and references therein]. Grains studied spectroscopically in interstellar environments are however much smaller with a sub-micron mean size [1]. Grains studied in the laboratory to date therefore may not be typical of the majority of grains in space. Although the Cameca Nano-SIMS [2] is helping to fill this gap through the capability of measuring isotope ratios of major elements with a spatial resolution down to 50nm, analysis is still restricted to the major abundance elements. A further disadvantage is that only one or two elements at a time can be measured during which time most of the sample is destroyed. We have therefore taken a different approach to the problem and constructed a new TOF-SIMS instrument (Time-of-Flight Secondary Ion Mass Spectrometer) with the capability for UV photoionization of sputtered neutral atoms.

TOF-SIMS with UV laser photoionization:

Our new instrument has been built to a similar design to the BIO-TOF instrument designed at UMIST and Penn. State University [3]. It uses a pulsed gallium primary ion gun to sputter secondary ions and atoms from the sample with a spatial resolution down to ~100nm. In SIMS mode, secondary ions are extracted and mass analysed using a reflectron to provide mass resolutions of upto 3000. The primary beam may be rastered over the sample to build up an image, each pixel of the image containing a complete mass spectrum. A major advantage of TOF-SIMS compared with the nano-SIMS instrument is the simultaneous detection of ions of all elements so that information on all element and isotope ratios is acquired and not lost with the destruction of the sample. Molecules may also be detected. The disadvantages are a lower ionization efficiency for many elements than the Cs gun of the nano-SIMS and poor duty cycle meaning a much longer time required to acquire good counting statistics. To overcome the problem of relatively poor ionization efficiency, we use a 157nm fluorine excimer laser (GAM lasers, 750Hz, 4mJ per pulse) to photoionize all elements with ionization potentials below 7.9eV (the vast majority of the heavier elements of the periodic table).

Working parameters and data acquired demonstrating the capabilities of the instrument will be given.

References: [1] Bernatowicz T and Zinner E (Eds), 'Astrophysical Consequences of the laboratory study of presolar materials' AIP Proceedings 402, AIP, Woodbury, New York, 1997, [2] Slodzian et al. (2003) Appl. Surf. Sci, **203**, 798-801, [3] Braun et al., (1998) Rapid Commun. Mass Spectrom. **12**, 1246-1252