DECAY OF REACTIVITY INDUCED BY SIMULATED SOLAR WIND IMPLANTATION OF A FORSTERITIC OLIVINE K. R. Kuhlman[1], K. Sridharan[2], D. H. Garrison[3], D. S. McKay[3] and L. A. Taylor[4]
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Introduction: In returning humans to the Moon, the Lunar Airborne Dust Toxicity Advisory Group (LADTAG) must address many problems faced by the original Apollo astronauts. Major among these is control of the fine dust (<20 μm) that makes up ~20 wt% portion of the lunar surface. This ubiquitous, clinging, sharp, abrasive, glassy dust caused a plethora of problems with seals, abrasion, and coatings, in addition to possible health problems, including 'lunar dust hayfever.'

The lifetime of reactive sites on the surfaces of irradiated lunar dust grains is of interest to those studying human health because of the free radicals and toxic compounds that may be formed and may not passivate quickly when exposed to habitat/spacecraft air.

Methods: Using plasma source ion implantation (PSII) [1] we irradiated a sample of flat, polished lunar analog forsteritic olivine, from the Twin Sisters mountain range in Washington State. The compositon of this olivine is approximately $Fo_{90\text{-}92}$ [2]. The sample of forster was marked with fiducial marks using a microindetner Approximately 20 reference spectra were taken within the fiducial marks to provide the unimplanted average spectrum as well as error bars for the measurements.

The implantation fluences used were 10^{16}/cm^2 4keV ^{4}He, 10^{14}/cm^2 3 keV ^{3}He and 10^{17}/cm^2 1 keV H, implanted in this order to avoid knock-on broadening of the lower-energy implantations. A TRIM simulation of the theoretical implantation depths is shown in Figure 1 [3]. These fluences were selected to approximate the saturation of solar wind volatiles in the lunar regolith [4]. Once the sample had been irradiated, it was immediately removed from the vacuum under a nitrogen backfill and quickly transfered in air to the Raman spectrometer. The air temperature was measured to be approximately 25 C and the relative humidity was approximately 10%. The previously measured fiducial marks were then located This procedure necessarily resulted in the loss of reactivity data during the transfer which takes approximately 7-10 minutes.

Raman spectroscopy was used to monitor the decay of reactive sites caused by the implanted species. The peaks in Raman spectra are very sensitive to changes in the chemical environment. A green laser wavelength of 532 was used with a 50X objective, resulting in incident laser power of approximately 17.9 mW. The peaks observed and measured are the two large Si:O peaks present at approximately 825 cm^{-1} and 856.7 cm^{-1} (Figure 2).

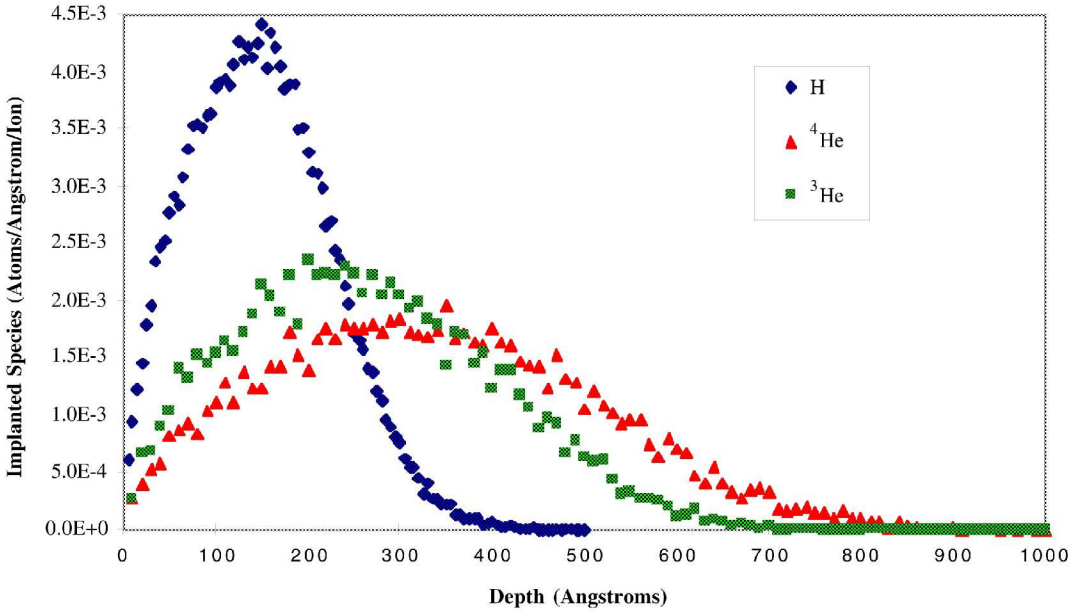

Figure 1. TRIM generated implantation profiles for 4 keV ^{4}He, 3 keV ^{3}He keV, and 1 keV H.

Results: Irradiation of the forsterite not only caused the Raman peaks to shift, but caused peak broadening. This effect was particularly pronounced in forsterite where half-lives of the reactivity in air were measured to be 155 min ± 24.3 for the Raman peak at approximately 825 cm^{-1} (Figure 3) and 146 min ± 25.2 for the peak at approximately 856.7 cm^{-1}. Peak broadening of approximately 1 cm^{-1} was seen for both peaks.

References: [1] Conrad, J. R. (1988) United States patent 4,764,394. [2] Ferre, E. C., B. Tikoff, and M. Jackson. (2005) *Tectonophysics* 398:141-166. [3] Ziegler, J. P. (1996) Yorktown, New York: IBM – Research, [4] Borg J., Chaumont J., Jouret C., Langevin Y., and Maurette M. (1980) (R. O. Pepin, J. A. Eddy, and R. B. Merrill, eds.), pp. 431–461. Pergamon, New York.

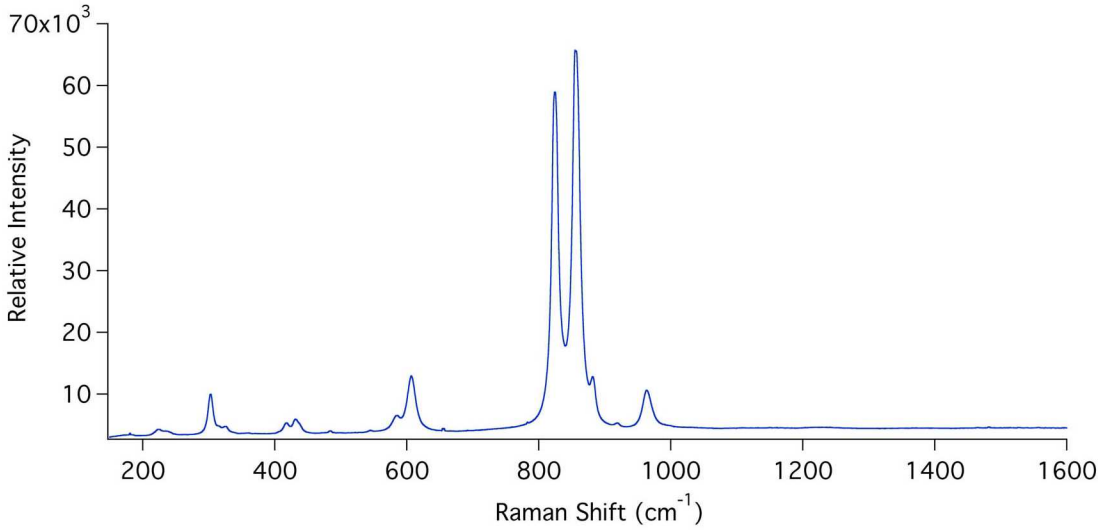

Figure 2. Example Raman spectrum of Twin Sisters forsterite olivine.

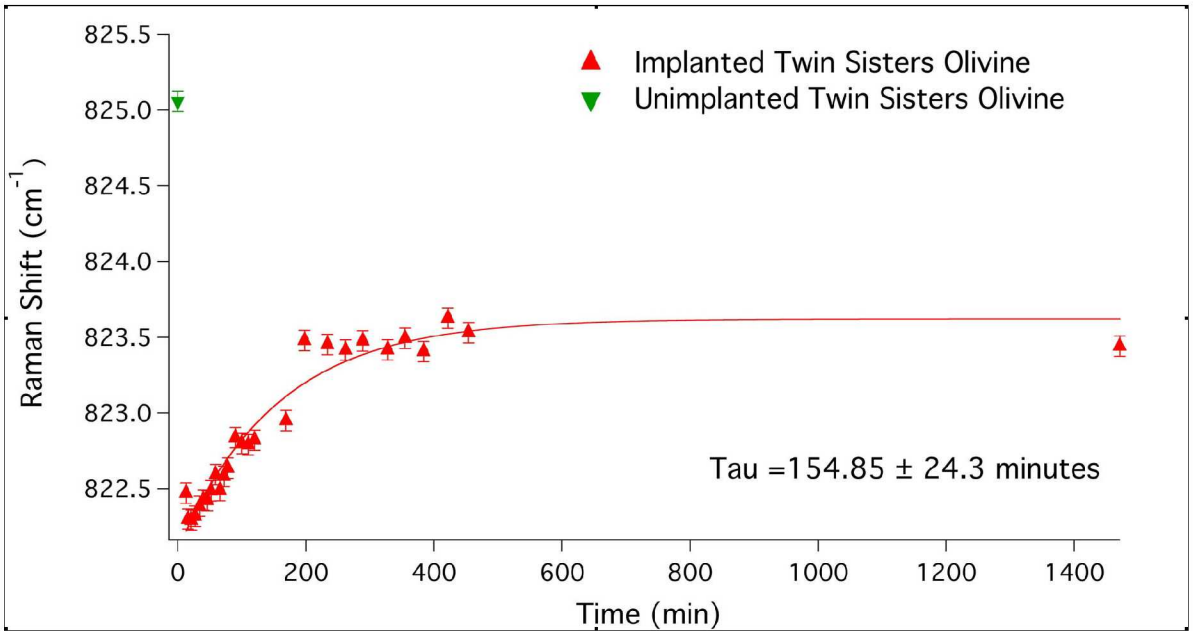

Figure 3. Decay of irradiation-induced reactivity using forsterite peak about approximately 825 cm^{-1}.