CO₂ LASER-HEATING EXPERIMENTS ON APOLLO 11 LUNAR FINES 10084. J. L. Jordan¹, G.M. Irwin², and S. A. Miller³, ¹Department of Earth and Space Sciences, P.O. Box 10031, Lamar University, Beaumont,Texas 77710, jordanjl@hal.lamar.edu, ²Department of Chemistry and Physics, P.O. Box 100xx, Lamar University, Beaumont, Texas 77710, irwingm@hal.lamar.edu , ³Department of Earth and Space Sciences, P.O. Box 10031, Lamar University, Beaumont, Texas 77710.

Introduction: We report Mössbauer spectroscopy and mass spectrometry measurements on CO₂ laser-heated Apollo 11 lunar fines 10084. The purpose of these experiments of these experiments was to determine the power density for releasing solar wind implanted gases from lunar fines and the power density required for complete melting of the fines. Such information provides constraints on the use of the CO₂ laser and other heating techniques in resource exploration and resource processing of the lunar regolith[1,2].

Laser-heating experiments: For the Mössbauer spectroscopy measurements heating experiments involved three 10 minute rasters, with sample homogenization between rasters, with laser power settings at 2, 3.5, 5, 7, and 10 Watts, in a vacuum of ~10⁻³ torr. For the mass spectrometry measurements the sample was exposed to the laser for one minute in a vacuum of 10⁻⁹ torr before measurement of the released gases.

Mössbauer spectroscopy measurements. The purpose of the Mössbauer measurements was to characterize the glassification of the material from partial to complete melting, and in particular to note the changes in the ilmenite component, which is a primary retainer of solar wind gases. A four component method was used to fit spectral lines. This method allowed extraction of relative absorption due to ilmenite (crystalline Fe³⁺) and glassy Fe³⁺, as well as Fe²⁺ silicate phases. Fig. 1 shows the results for the heated lunar sample 10084. Note that the increase of total Fe³⁺ content (filled circles ●) is equal to the decrease in Fe²⁺ (open circles ○), indicating that some of the ferrous silicates are oxidized in the heating process.

Mass spectrometry measurements. We measured the release of He, Ne, and Ar from lunar sample 10084 as a function of laser power with the SXP 50 quadrupole mass spectrometer in our laboratory. These inert gases were chosen to represent the mass range of most volatile gases of interest, and to avoid complexities that may result from reactive gases The released gases were subsequently measured. Solar wind origin of these gases was confirmed from the ⁴He/³He ,²⁰Ne/²²Ne, and ⁴⁰Ar/³⁶Ar ratios. The quantities given in ccSTP were obtained from the measured signal and an instrument calibration from known quantities of the gases of interest. The results shown in Fig.2 indicate that peak release occurs at approximately 2W and degassing is nearly complete above 3W.

Conclusion: The laser power density (W/cm²) for complete melting determined from Mössbauer spectroscopy measurements of the heated material is in the range 80-100 W/cm². The mass spectrometry measurements results correspond to a power density range between 25-35W/cm² for near complete release of solar wind implanted gases.