LASER ABLATION EXPERIMENTS ON THE TAMDAKHT H5 CHONDRITE

S.M.White[1] and E.C. Stern[2], NASA Ames Research Center, Moffett Field, California 94035 USA,
[1]Susan.White@NASA.gov [2] Eric.C.Stern@NASA.gov.

During entry of Earth's atmosphere, meteoroids typically lose a large fraction of their mass from ablation, melt flow, vaporization, and spallation. The meteoroid ablation process has been modelled to the first order using a single ablation parameter [1]. However, ablation is a complex thermochemical phenomenon, and the ablation rate is a function of many variables, including the meteoroid's material properties, size, velocity, and altitude. In order to improve understanding of meteor ablation in both qualitative and quantitative terms, a series of ground tests is in progress. Radiation is the primary source of heating during earth atmosphere entry to the larger meteoroids of interest to our project. Existing ground test facilities cannot simultaneously simulate all the relevant variables influencing ablation during a meteor entry, including radiative and convective heating, temperature, pressure, and shear. Therefore, radiative heating was tested separately from convective heating, and is described in this work.

High-powered lasers were used to ablate samples of the Tamdakht H5 chondrite as well as terrestrial basalt, at heating rates comparable to flight. These ground tests were undertaken to improve our understanding, and ultimately improve our abilty to model and predict, meteoroid ablation during atmospheric entry. An infrared fiber laser at the LHMEL facilty, operated in the continuous wave (i.e. non-pulsed) mode, provided radiative heat flux at levels similar to meteor entry for these tests. Results are presented from the first round of testing on samples of Tamdakht H5 ordinary chondrite which were exposed to entry-relevant heating rates between 5 and 15kW/cm^2. These test demonstrate that laser exposure at these heating rates forms fusion crusts on meteorites similar to those created during atmospheric entry. During testing, high speed video provides insight into surface melt, vaporization, and spallation phenomena. Qualitative and quantitative data from this experiment suggest that there is significant attenuation of the incident radiative heat flux due to absorption by or scattering from ablation products. UV/VIS/NIR hemispherical reflectance was measured for the test materials before and after testing. These spectrometery measurements show that the laser ablated chondrite developed fusions crusts which are spectrally similar to naturally formed meteorite fusion crust. The effects of observation viewing angle were investigated with sensors located at 15, 30 and 45 degrees from normal, showing nearly identical reflectance at 30 and 15 degrees, but a decrease in the reflectance at 45 degrees versus 15 degrees, which could be of interest to remote sensing observations.

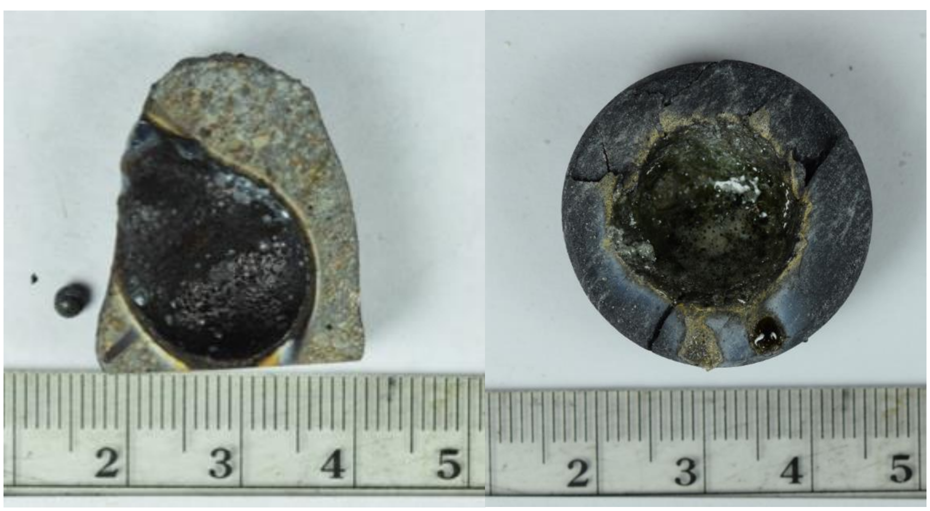

Figure 1. Tamdahkt chondrite and Basalt test models showing fusion crust and melt casused by laser testing.

References:

[1] Öpik E. J., *Physics of Meteor Flight in the Atmosphere*, Dover Press, 1958