FOUR-COLOR TEMPERATURE AND POWER MEASUREMENTS IN HYPERVELOCITY DUST IMPACT.

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Introduction: The characteristics of impact-generated plasmas are of interest in many disciplines of planetary science, from space-based detection systems to planetary cratering processes. Details of the impact process, especially at early times, are difficult to investigate experimentally because of the short time and length scales involved. Pioneering experiments in the 1970s [1,2] established that impact-generated light flash can provide a window into the changing conditions in the expanding cloud on the tens-to-hundreds of microseconds timescale.

We present time-resolved, four-color measurements of the light flash caused by hypervelocity dust impact across a variety of target materials, at speeds up to 60 km/sec. Reconstruction of the temperature and effective radiating area on a time-resolved basis permits investigation of the radiant power as a function of time, and makes possible investigation of scaling of both temperature and the total radiated energy with velocity.

Experiment Description: Micron- and submicron-sized iron dust grains were launched at speeds from 1-60 km/sec, using the electrostatic dust accelerator facility at the Colorado Center for Lunar Dust and Atmospheric Studies (CCLDAS). Dust grain impacts at these speeds produce a 1-100 microsecond long flash of light in the visible spectrum. A set of four photomultiplier tubes equipped with narrowband interference filters observe the flash in each of four spectral bands; this information is then used to reconstruct the temperature and radiating area of the debris cloud as a function of time.

A nonlinear least-squares fit was used to determine the best-fit blackbody temperature and radiating area which reproduced the observed four photocurrents. Fits were carried out using photocurrents for the first 1 microsecond of the flash, in addition to longer time-resolved fits on the 10-100 microsecond scale using an exponential model for the photocurrent. Error bars were established using a Monte Carlo procedure which determined the effect of photocurrent uncertainty on the resulting temperature and area fits.

Discussion: Experiments were carried out for a variety of target materials including tungsten, quartz, tantalum, vanadium, and gold. In the case of tungsten, we find a temperature drop on the 10-microsecond timescale consistent with radiative cooling. All materials except for gold demonstrated temperature increases as a function of velocity; in addition, tungsten displays a step in the temperature at approximately 10 km/sec.

Our results demonstrate the initial temperature is a function of both the target material and the impactor velocity, and hint at a transition around 10 km/sec for tungsten, and with less confidence, tantalum. These results, and the limitations of the blackbody assumption, also underscore the need to acquire full spectra of the impact-generated light flash.

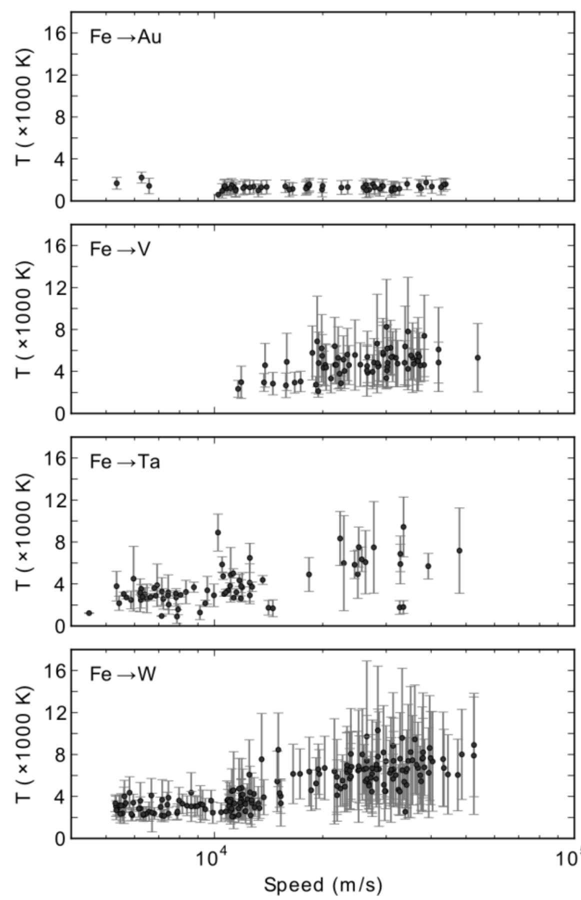

Figure 1: Initial (1-microsecond) temperature observed to iron impacting various target materials. A four-color blackbody temperature fit was used.

[1] Eichhorn, G. (1975) *Icarus, 23 (11)* 1519-1525. [2] Eichhorn, G. (1978) *Icarus, 26 (5)* 463-467.