EFFECTS OF AEROGEL DENSITY ON INTACT CAPTURE

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The successful demonstration of the technology of capturing micrometeoroid analogs intact in passive underdense media offered a valuable tool to cosmic dust research [Tsou 1984]. Actually, it is very tedious to locate and remove cosmic dust impacts on flat surfaces; therefore, the task of analyzing cosmic dust from solid capture media can be nearly impossible. However, if a capture medium is transparent, making visual particle identification easy, and still possesses the ability to capture hypervelocity particles intact, the analysability of intact capture in solid media is immensely enhanced. Silica aerogel was shown to possess both the desired degree of transparency and an acceptable intact capture capability [Tsou 1988]. Since our introduction of silica aerogel as a capture medium, both the density and transparency of aerogel has been greatly improved. This abstract reports the results of experiments on intact capture of hypervelocity projectiles with wide ranging silicate aerogel densities from 150 to 5 mg/ml.

Although polymer capture media have been shown to be more efficient in capturing small particles intact [Tsou 1989], the ease of visual identification in transparent aerogel enhances the analysis immensely. Typically, intact capture produces a characteristic track, on the order of 100 to 200 particle diameters in length, having a wide initial portion and a tapering remainder much like a carrot such as is found in polymer capture media. Due to the fracture nature of glass, the carrot track in silica aerogel looks much like an inverted Christmas tree, with the tip of the tree pointing to the captured particle. Identifying this inverted Christmas tree track, even for micron-sized particles in transparent aerogel is quite easy. Furthermore, since silica aerogel can be made with very low hydrocarbons, analyzing for biogenic elements and compounds is made feasible.

EXPERIMENTS
Olivine projectiles, made by flame spraying, and sieved commercial soda lime glass beads were launched in the NASA Ames Vertical Gun Range in the cluster mode as previously described [Tsou 1988]. Up to four different density silica aerogels were simultaneously exposed as capture media in the same experiment. In doing so, the capture media would experience the same test parameters (e.g. speed), the same projectile handling and the same chamber environment (e.g. vacuum). The diameters of spherical olivine were ranged from 90 to 125 microns; the glass spheres were 20 to 38 microns in diameter. Silica aerogels of six different densities were tested: 5, 8, 10, 47, 88 and 150 mg/ml. These are nominal densities; up to 25% density nonhomogeneity within any given piece of aerogel is expected. Due to the fragile nature of the low density aerogel and severe
hazardous environment of the test chamber, each individual aerogel had to be encased for protection. The test chamber is evacuated to around 5 mm of Hg. Launch speeds in these experiments ranged from 5.7 to 5.9 km/s.

CAPTURE & ANALYSIS
Cluster experiments generate inherently averaged, rather than individual data, since projectiles in a cluster vary in size. Glass projectiles with diameters of 20 to 38 microns in our experiments would present 3.6 times variation in the cross-sectional area and 6 times the kinetic energy for perfect spheres. Particles used in these experiments are not all perfect spheres, making an even wider variation in track morphology (e.g. track lengths). Consequently, one-to-one comparisons between a specific sized projectile at a specific speed among different aerogel densities would be difficult to achieve.

Intact projectiles of olivine and glass were recovered from all of the aerogels. At the end of each track, a solid particle is clearly visible, even in the 150 mg/ml aerogel. Our expectation of decreasing intact recovery with the increase of aerogel density is confirmed by smaller particles recovered in higher density than in lower density aerogels.

The most noticeable difference among the aerogels is the capture track morphology retained within the aerogels. Up to 10 cm tracks were produced in 10 mg/ml aerogel by olivine projectiles and 2 cm tracks for glass projectiles. The longest tracks in 150 mg/ml aerogel are 9 mm and 1 mm, for olivine and glass, respectively. The track lengths in 47 and 88 mg/ml aerogels seem to behave according to the density effect. The track profile is significantly different for the 150, 88 and 49 mg/ml aerogels than for those of lower densities, fracture lines are very pronounced for the higher density aerogels, resembling a Christmas tree appearance with fracture lines emanating radially from the edge of the track wall. Track morphology in the lower density aerogels seems to look much like that in polymer foams having smooth track walls without fracture lines but with significant track skewing. The projectiles are lodged about 60° from the track at the end of a hook. The integrity of a 5 mg/ml aerogel is just too weak for the experimental environment; any significant clusters of projectiles would excavate an entire section. The usefulness of aerogel below 10 mg/ml is doubtful for the intact capture of hypervelocity particles.

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REFERENCE