INTACT CAPTURE OF COSMIC DUST ANALOGS IN AEROGEL

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The feasibility of capturing hypervelocity cosmic dust analogs intact in silica aerogel has been demonstrated [1]. This technique is important for both the 'intact' capturing of unmelted fragments of cosmic dust in Earth orbital experiments and for comet coma flyby sample return missions. We report here the recent progress made in laboratory development involving the capturing of micron-sized projectiles by an electrostatic accelerator and the capturing of micrometeoroid analogs by a plasma drag gun.

In spite of the success in demonstrating intact capturing in very low-density (50 mg/ml) silica aerogel in a two-stage light-gas gun, there is a need to explore the limits of capturing projectiles varying size, speed and launch conditions. The ability to capture intact the very small analogs at higher speeds would increase the confidence in capturing larger dust at lower speeds. Different projectile launch techniques will render the launched projectiles at different physical states before they are captured in the medium.

An electrostatic accelerator offers higher-speed launches than possible with a two-stage light-gas gun albeit it is restricted to very small iron projectiles. The 2-MV electrostatic accelerator at the Max-Planck Institute for Nuclear Physics can launch micron-sized carbonyl iron spherules at about 5 km/s and submicron-sized spherules up to 30 or more km/s. The Los Alamos National Laboratory's 6-MV ion beam facility has been adapted just recently for electrostatic acceleration of submicron-sized carbonyl iron spherules to 100 km/s and beyond [2]. With these facilities, we have explored the capture of micron-sized iron spherules from a few km/s up to fifteen km/s in very low-density (60 mg/ml) silica aerogel. As part of multiple foil capture experiments of the Washington University at the Technical University of Munich , we were given an opportunity to test the capturing of nominal 100-um sized soda lime glass projectiles launched with the plasma drag accelerator at speeds from 2 to 6 km/s and captured by very low-density (50 mg/ml) silica aerogel.

<u>ELECTROSTATIC ACCELERATION</u> Nine experiments with iron projectiles at speeds from 2 to 12 km/s were performed with 50 mg/ml silica aerogel at the horizontal Max-Planck Institute electrostatic accelerator. Aerogel was placed in a holder taped to the end of the chamber evacuated to high vacuum. Only the very small projectiles were rejected by electrostatic deflection. Typically, a half-hour long waiting time was required for a larger micron-sized projectile at 5 km/s. At 12 km/s, the projectiles were typically about half a micron-sized. At the vertical Los Alamos facility, fourteen experiments were performed with 60 - 70 mg/ml silica aerogel at speeds up to 14.5 km/s. Aerogel pieces were placed in the pockets of a rotating disk, eight at a time. A narrow size range for the projectiles from 0.5 to 1.5 um was set for the experiments, except for one experiment in which size and speed deflections were turned off, allowing projectiles of all sizes and at all speeds.

At Max-Planck Institute, narrow, tapered, and thin tracks in the aerogel were seen optically by scattered light for up to 10 - 12 km/s range experiments. Projectiles were clearly seen at the end of long tracks. By optical examination, the Los Alamos experiments indicated that for 9 - 14 km/s the tracks were short and tubular with no visible single projectile. For slower speeds, confirmed intact capture has been verified albeit one large solid projectile is typically found with many smaller pieces along the track. Figure 1 shows a typical track (178 um long) with a 2.5-um solid particle at the end of the track. Individual micron-sized projectiles were extracted from aerogel. Energy dispersive X-ray analysis of the extracted projectiles confirmed that they are iron in composition.

PLASMA DRAG ACCELERATION One piece of 7-cm diameter 50 mg/ml aerogel was placed behind two foils 1 cm apart and 2 mm in front of the aerogel at the end of the horizontal evacuated test chamber. The first polymer foil, 500 A thick, was used as plasma generator for speed determination. The second foil was 1000 A aluminum to provide projectile size detector. There were many more holes in the aluminum foil than detected tracks in the aerogel. The impacts consisted of a spray of hundreds of soda lime glass and metals with speeds varying from 2 to 6 km/s. Based upon the holes in the aluminum foil, glass projectiles ranged from 10 to 80 um, with larger sizes corresponding to lower speeds and smaller sizes to higher speeds. Since there were many more projectiles than separable plasma signals, associating a specific speed with a specific projectile will be difficult.

Typical carrot-shaped tracks were detected with a solid mass lodged in the end of the track as we have seen before; however, multiple breakage were detected for most of the captured projectiles. Projectile pieces were extracted individually for surface and cross-sectional analyses. Figure 2 shows a optical image of one of the captured projectile in pieces. Recovered objects were confirmed to be soda lime glass.

FINDINGS Micron-sized iron projectiles can be captured intact in aerogel at hypervelocities. Further experiments and analyses will refine the quantitative scope of this capability. The capturing of micron-sized projectiles suggests the possibility of capturing interstellar dust which is typically in the size range of a micron. No definitive correlations can be made with the capture of glass projectiles in aerogel by a two-stage light-gas gun since the integrity of the projectiles before capture in the plasma drag gun and speed were unknown.

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REFERENCES [1] Tsou, P. et al. (1988) LPSC 19. [2] Keaton, P. W. et al. (1989) 1989 HVIS.

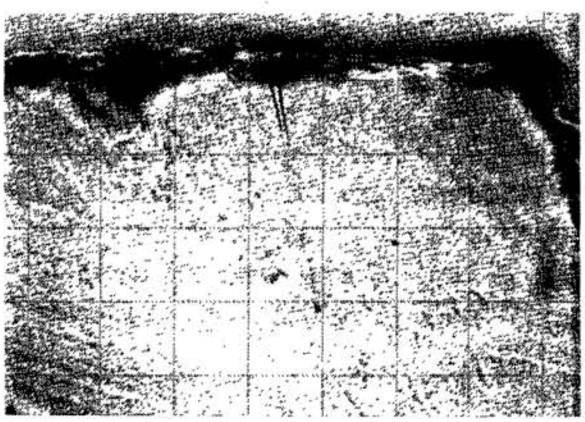

Fig 1. Iron Projectile

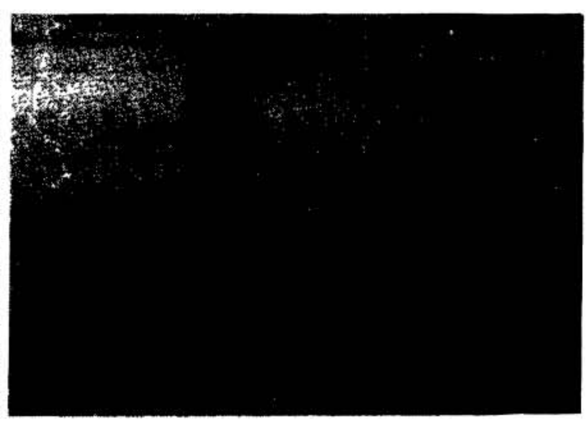

Fig 2. Soda Lime Projectile