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Density Estimation from Impact Track Morphology in Silica Aerogel: Application to Dusts of Comet 81P/Wild 2

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Cometary dust particles of Wild2 have been successfully collected and returned in Stardust Mission [Brownlee et al. (2006) Science 314, 1711-1726]. Hypervelocity capture (6.1 km/s) of those particles mandated various degrees of heating, fragmentation and evaporation of the projectiles during their capture process in silica aerogel [Zolensky et al. (2006) Science 314, 1735-1739]. Nevertheless, an impact track formed by each particle can be an indicator of its original properties [Horz et al. (2006) Science 314, 1716-1719]. Particle size dependence of track properties has been studied in several papers [Burchell et al. (2009) Planet. Space. Sci. 57, 58-70; Horz et al. (2009) Meteo. Planet. Sci.44, 1243-1264] and impact tracks in Stardust aerogel formed by several sized soda lime glass beads of different sizes were used for calibration of Wild2 dust size distribution [Burchell et al. (2008) Meteo. Planet. Sci. 43, 23-40]. In the work of Iida et al. [(2010) Meteo. Planet. Sci. 45, 1302-1319], three-dimensional structures of Stardust impact tracks were analyzed and Wild2 dust density was estimated based on their track formation model. However, density dependence of track properties has not been investigated precisely yet. Therefore, we carried out impact experiments into silica aerogel (20 mg/cc) using projectiles of several densities in order to clarify the relation between projectile properties (size and density) and track morphology.The experiments were carried out with a two-stage light-gas gun at ISAS, JAXA. The projectiles we used were bubble glass (0.5 g/cc) polystyrene (1.06 g/cc), sintered silica (˜1.3 g/cc), soda lime glass (2.5 g/cc), alumina (3.9 g/cc), and copper (8.9 g/cc). All the projectiles except for sintered silica were spherical in shape. Size of these impactors ranged from ˜0.03 to ˜0.1 mm in diameter and they were fired into 20 mg/cc silica aerogel at ˜6 km/s to simulate the capture of Wild2 dust. All the individual impact tracks were observed with an optical microscope. The results show that track length (Lt) depends on projectile size and density while maximum track width (Dm) mainly depends only on projectile size. Therefore, aspect ratio (Lt/Dm) does not change with projectile size, but only with projectile density. This means that when we estimate projectile properties from a track shape, Lt/Dm is a good indicator of projectile density.This can be applicable for Stardust impact tracks; densities of Wild2 dust particles are estimated by examining the relation between projectile density and aspect ratio of a track in Stardust aerogels.