Electrospray Charging of Minerals and Ices for Hyper-Velocity Impact Research

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In situ chemical characterization of interplanetary, interstellar, and cometary particulates has often been accomplished using time-of-flight mass spectrometry of the plasma resulting from high-velocity impacts of these particulates on dense targets. The CIDA on Stardust and the CDA on Cassini, examples of such instruments, have provided a wealth of data on cosmic dust. However, extrapolating from elemental or molecular species detected by these instruments to the original particle composition is not straightforward, even with laboratory calibration. Existing methods of creating hypervelocity microparticle impacts in the lab are limited to conducting projectiles, either metal particles or particles that have been coated with metals or conductive polymers. The requirement of conductivity creates a real barrier to understanding the details of the chemistry occurring during the impact, and hence, deriving particle composition, especially for volatile or fragile chemical species that may be present in cometary particles.

We present a new technique that can charge non-conducting particles for laboratory impact experiments. Our experiments demonstrate that electrospray, commonly used to ionize biomolecules and organic molecules, can also be used to charge microparticles of minerals and mineral-ice mixtures. Our experimental setup allows electrosprayed particles to be introduced into vacuum and detected using image charge. Over 10,000 micrometer-sized quartz particles have been detected in our lab, typically with hundreds to thousands of elementary (positive) charges. Although this represents a surface charge density 1-3 orders of magnitude lower than what can be done with conducting particles, electrospray can charge smaller particles, and the composition of these particles can more closely approximate real systems. Details of the method and results will be presented, as well as plans to begin integrating this new dust source with existing accelerators.

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