

The Deep Space 4/Challengenger Comet Simulation Laboratory

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A new laboratory for comet simulation is under development at the Jet Propulsion Laboratory to support the Deep Space 4/Challengenger mission. This laboratory will provide essential research and products for the test and development programs for the comet lander. In particular, the activities and products of the Comet Lab will help decrease cost and risk by providing state-of-the-art simulated cometary materials for the active test-and-design cycle used in the development of the DS-4/Challengenger drilling and anchoring systems. The laboratory activities combine basic research in cometary materials and cometary analogs, and the development of basic techniques and procedures for large-scale materials simulation and the heavily-applied activities of designing and fabricating 1000 kg test articles for the DS-4/Challengenger Test Programs. Specifically in 1998, laboratory work focuses on developing the capabilities to: (1) Experimentally measure and verify values of strength and density of cryogenic cometary simulants; (2) Develop "room temperature," low cost, cementitious materials that have compressive strengths that match those of the cryogenic cometary simulants; and (3) Construct test articles for the DS-4/Challengenger Anchoring Test Program, that may be homogeneous, or vertically and horizontally inhomogeneous, based on the results of the laboratory work done with cryogenic cometary simulants. First and foremost of the new hardware capabilities is the cryogenic vacuum chamber that will provide the space-like environment for the development and evolution of the cometary simulants. These materials will be used to determine "reasonable" values and to set limits on expected real cometary materials properties. This system consists of a ~1 m diameter vacuum chamber fitted with an instrumented cylindrical (r=10cm, h=20cm) sample holder that will hold the icy-dusty mixtures. This cold-shrouded, initially High Vacuum (10^{-6} Torr) system, will also have a solar analog lighting system to simulate cometary insolation. The sample and interior of the vacuum chamber will be instrumented to monitor the behavior and evolution of the simulated cometary materials sample. Instruments will include a mass spectrometer to monitor outgassing molecular species fluxes, video system to monitor dust and gas eruptions, and a possible dust flux analyzer. Fresh simulated cometary materials will be fabricated and placed into the chamber. The sample will be subjected to a test program that will simulate the types of insolation environments expected for a cometary nucleus. Upon completion of this phase, the sample will be removed, inspected, and have its properties (e.g., compressive strength and density) measured. These results will feed into subsequent cryogenic tests and into the development program for room temperature analogs. While the cryogenic vacuum system is the most substantial of the items currently under development, there are several smaller systems that are being designed and fabricated or simply purchased. These include: ice mixture maker, ice compression tester, cryogenic glove box, cryogenic freezers for long term storage of samples, and a walk-in freezer for laboratory testing. The Comet Laboratory activities will complement and extend the research performed in the German Kometen Simulation program. This is a combination of basic science and engineering that supports and enhances the mission success of Deep Space 4/Challengenger.