



NASA SBIR 2009 Phase I Solicitation

X6.02 Surface System Dust Mitigation

Lead Center: GRC

Participating Center(s): ARC, GSFC, JPL, JSC, KSC, LaRC, MSFC

The general objective of the subtopic is to provide knowledge and technologies (to Technology Readiness Level (TRL) 6 development level) required to address adverse dust effects to exploration surface systems and equipment, which will reduce life cycle cost and risk, and will increase the probability of sustainable and successful lunar missions. The subtopic will help to develop a balance of near- and long-term knowledge and technology development, driven by Exploration Systems Mission Directorate needs and schedule requirements, aligned with existing technology investments where possible. The technical scope of the subtopic includes the evaluation of lunar dust effects and development of mitigation strategies and technologies related to Exploration Surface Systems, such as: Rovers and Robotic Systems, In Situ Resource Utilization (ISRU) Systems, Power Systems, Communication Systems, Airlock Systems and Seals, Habitats, and Science Experiments.

Lunar lander and surface systems will likely employ common hatch and airlock systems for docking, mating, and integration of spacecraft, habitat, EVA, and mobility elements. The large number of EVAs will require hatches that are safe if non-pressure assisted, and do not have to be serviced or replaced regularly. Lunar lander and surface systems will require materials and mechanisms that do not collect dust and do not abrade when in contact with lunar regolith. Technologies are also needed to remove lunar regolith, including dust, from materials and mechanisms. Lunar Surface systems will require EVA compatible connectors for fluid, power, and other umbilicals for transfer of consumables, power, data, etc. between architecture elements that will maintain functionality in the presence of lunar regolith, including dust. Lunar surface systems (power, mobility, communications, etc.) will require gimbals, drives, actuators, motors, and other mechanisms with required operational life when exposed to lunar regolith, including dust. Radiators and other thermal control surfaces for lander and surface systems must maintain performance and/or mitigate the effects of contamination from lunar regolith, including dust.

Also included in the technical scope is the development of lunar regolith simulants. Simulants that are properly designed, analyzed, and produced are critical to understanding the effects of dust on humans and mission critical subsystems and how to handle and utilize regolith on the lunar surface. Proposals are requested in technology areas that improve simulant fidelities, reduce simulant manufacturing costs and schedules, and improve on simulant development processes and characterization techniques and methods.

Lunar Regolith Simulants

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- Should cost
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 - Be producible in quantities up to 30 tons/year;
 - Have reproducible production processes;
 - Have particle size distributions representative of lunar regolith from 0.5 to 1000µm in size.

The subtopic specifically requests technologies addressing dynamic mechanical systems used for lunar surface missions with potential to mitigate effects of lunar dust. For lubricated mechanisms, such as drives and pointing mechanisms, the sealing element must be durable enough to maintain a hermetic seal to prevent lubricant outgassing and dust contamination for at least 5 years. Also, the bearings, gears, etc of the mechanism must be robust enough to survive and provide nominal operation with lunar dust contamination and possible lubrication starvation.

Mechanical Systems

- Should achieve
- Should achieve dynamic seal wear life of 20 million cycles;
- Should achieve 300% improvement in bearing life (frictional torque vs. time) relative to lubricated SOA bearings contaminated with lunar fines.

The subtopic also requests proposals for advanced materials, coatings, and related technologies with the proper combination of physical, mechanical, and electrical properties, and lunar environmental durability, suitable for use in dust mitigation applications on the lunar surface.

Materials and Coatings

- Should demonstrate reduced initial contamination (>90%) compared to conventional materials;
- Should demonstrate improved efficiency of cleaning processes (>99% removal of initial contamination) without damage.

Another area of interest encompassed by this subtopic is alternative technologies for lunar dust removal that may be used in a variety of lunar surface applications. Both manual and automated cleaning systems are sought and may be derived from any or a combination of particle removal forces appropriate for use on the lunar surface.

Cleaning Systems

- Should demonstrate >99% removal of dust contamination. Tolerable contamination levels will be application specific.

Research should be conducted to demonstrate technical feasibility during Phase 1 and show a path to hardware or production demonstration in Phase 2. When possible, a demonstration unit or material quantity should be delivered for functional and environmental testing and characterization and evaluation at the end of Phase 2.