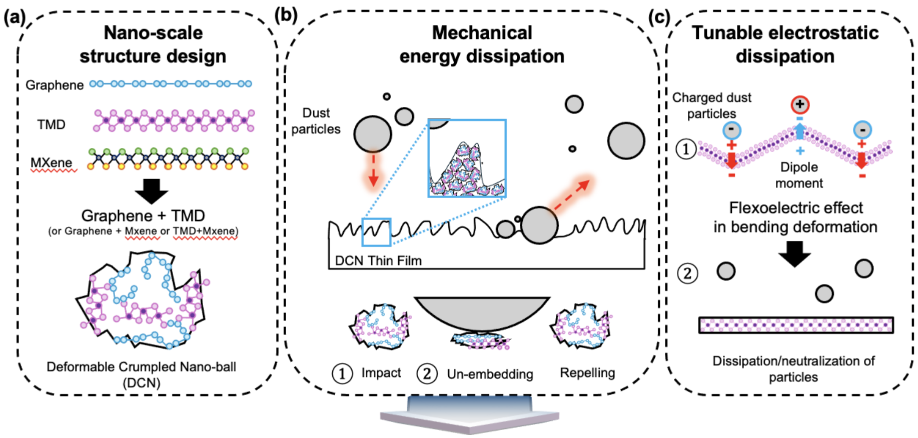
Deformable Crumpled Nano-ball Coatings With Adaptable Adhesion And Mechanical Energy Absorption For Lunar Dust Mitigation

PI: SungWoo Nam, University Of California, Irvine

UC Irvine

Research Overview: (a) The deformable crumbled nano-balls (DCNs) are synthesized from graphene, MXene, and TMD nanosheets. (b) DCN used to create a deformable thin film coating for lunar dust mitigation. (c) The shape-tunable electrostatic dissipation enabled by flexoelectric charge neutralization.



Developing coatings of mixed 2D nanostructures responsive to the lunar dust environment

RESEARCH OBJECTIVES

1. Synthesis of crumpling graphene, MXene, and TMDC nano-balls and fundamental investigations of their adhesion properties
2. Evaluation of DCN thin film coatings in thermal, vacuum, radiation, and wear environments
3. Experimental validation of DCN coatings for lunar dust mitigation in thermal, vacuum, and VUV

- ***Innovation:*** Leverage DCN coatings to engineer corrugated surfaces with minimal van der Waals adhesion as well as adaptive charge dissipation to reduce dust adherence and mitigate the impact on vital equipment and infrastructure.
- ***Comparison to SOA:*** State of the art relies on active (powered) dust mitigation or lacks mechanical robustness/reliability. Our proposed technology enables reliable, sustainable, passive, and adaptable electrostatic dissipation methods.
- ***TRL:*** Start at TRL 1 & Projected to be TRL 3 (at Year 3)

APPROACH

Task 1. Synthesis of DCNs and fundamental characterization

1.1 Uniform and efficient synthesis of crumpled nano-ball structures

1.2 Investigation adhesion properties using advanced microscopy techniques

Task 2. Evaluation of DCN coatings in extreme environments

2.1: Development of scalable thin film deposition

2.2: Lunar thermal and vacuum environment analysis

2.3: Lunar radiation environment and wear-resistance analysis

Task 3. Experimental validation of DCN coatings for lunar dust mitigation

3.1 Mechanical wear and abrasion resistance against lunar dust particles

3.2 Lunar dust charging and radiation resistance

POTENTIAL IMPACT

- Support NASA's Moon exploration mission via passive lunar dust control
- The robustness and versatility of our DCN coatings, could **lead to advancements in various industries requiring dust-resistant surfaces, from aerospace to electronics**
- The capability of these materials to provide superlubricity and electrostatic (and/or flexoelectric) dissipation suggests development of a **highly adaptive and responsive material for effective passive lunar dust mitigation**
- Potential applications in **creating ultra-low wear surfaces for mechanical systems**, which can drastically reduce maintenance needs and improve the energy efficiency of moving parts