



Devices and tools enabled by Advanced Manufacturing (AM) for Space Technology and Applied Research

Project 2

*Thermal Protection
System*

Thermal Protection System

- UDC team led by Dr. Tyagi and external collaborators (including Advanced Cooling Technologies, University of Maryland, and NASA Johnson Space Center) have been working on the task 1 in which methods to process the surface finishing of AM produced parts is being developed
- With the aim to fabricate space-application suitable surface finishing for AM produced components, through the development of Nano-manufactured variable emissivity coating with robust thermal and mechanical properties.

Smart VE Coating

- Internal Temperature Control of Satellite
- Smart Thermal Radiators for Outer Space
- Thermal Control of Spacecrafts
- Energy-Efficient Smart Windows

Smart Radiator

Project Title:
Nanofabrication of Smart Coatings with Variable Emissivity (VE) Capability for Metal AM Components in Spacecraft Thermal Protection Systems

VE Thermo-chromic Recipe:

Step 1:
W-doped VO₂ film (30 nm) is deposited on (100) Si substrates (>1000 Ωcm) using sputtering. The Tungsten doping content of VO₂ film is 2.1 at.% in order to reduce the phase transition temperature of VO₂ from 68 °C to around 32 °C. The stoichiometry of W-doped VO₂ film is V_{0.979}W_{0.021}O₂.

Step 2:
BaF₂ dielectric layer is then deposited on top of the VO₂ layer by Electron-Beam Evaporation.

Step 3:
Finally, Au layer of 200nm-thick is deposited on the BaF₂ layer by Electron-Beam Evaporation.

Coating/Devices on AM surface

Nano-manufacturing of Various Coating/Surface Finish on additively produced surfaces

Si Substrate
30 nm
W-doped VO₂
1500 nm
BaF₂
200 nm
Gold

IR

Smart VE Coating

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