Thermal Radiator EDS

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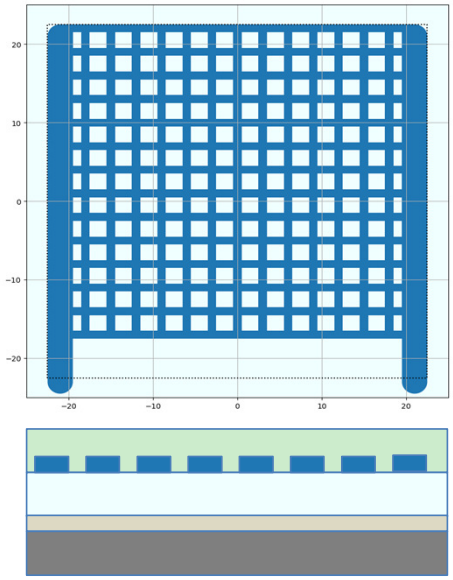
The EDS is a technology that uses high alternating electric fields to remove particles.

Electrodynamic Dust Shield:

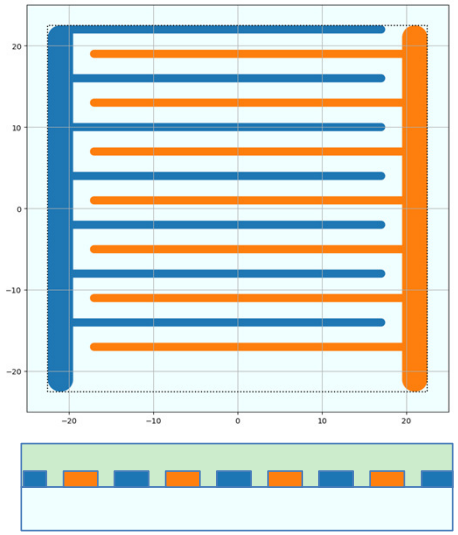
Out-of-Plane (3D) EDS:



Electrodes
Adhesive

Insulating layer
Substrate
Ground/ Other Phase

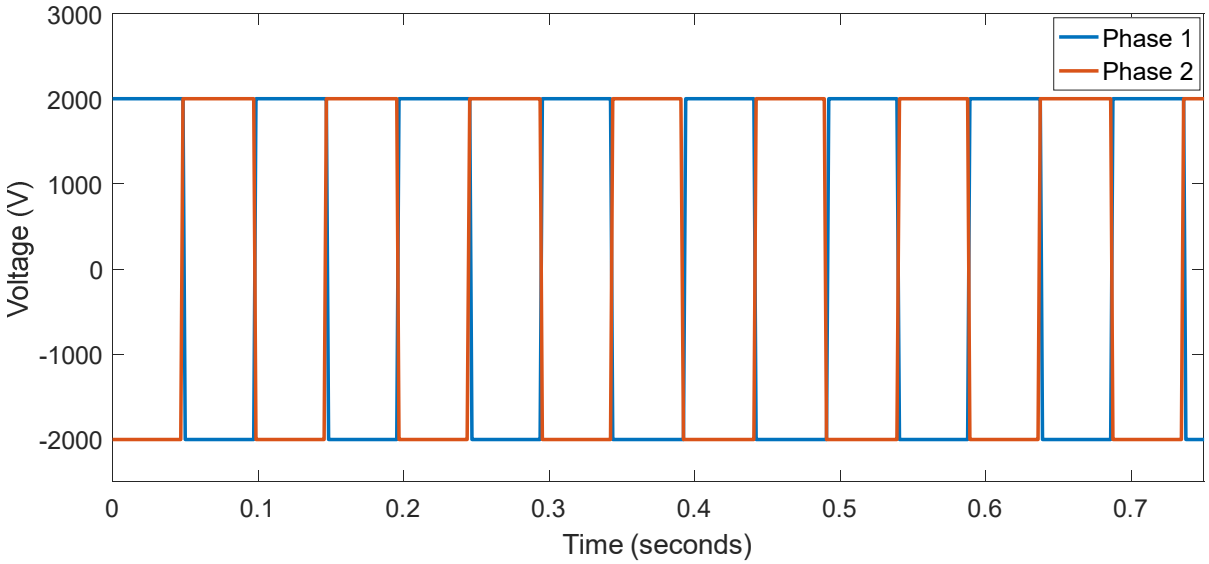
In-Plane (2D) EDS:



Electrodes

Insulating layer
Substrate

A square wave is used to operate the EDS for it's fast rise times.



Vacuum Testing:

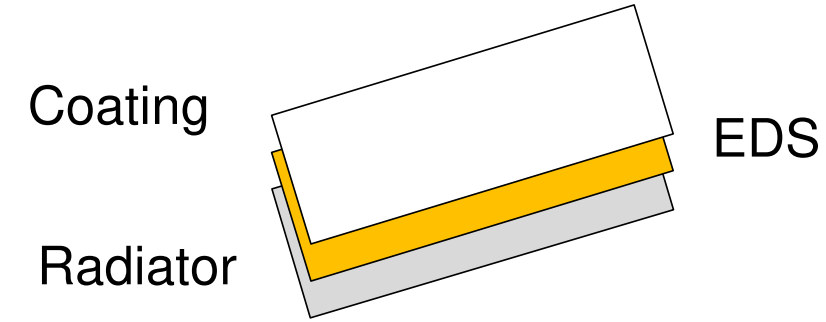
Range $1x10^{-4}$-10^{-6} Torr

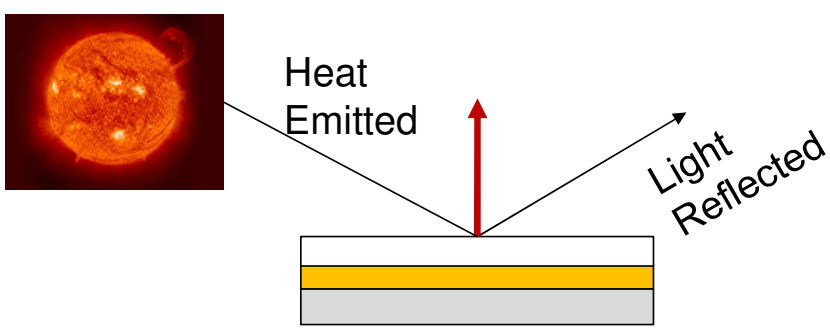
Voltage varies 1-4 kV

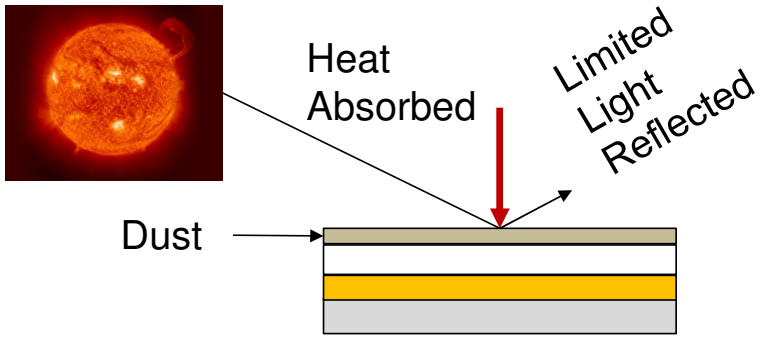
Frequency: ~10 Hz

Operation:
AC signal
DC signal for a minute (polarization)
AC signal

Dust hinders the radiators ability to reject heat.







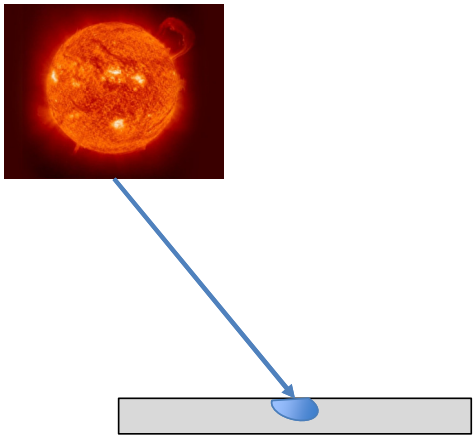
"As little as 12 percent dust coverage can degrade the α [solar absorptance] by as much as 50 percent."[1]

[1]Gaier et al. NASA Technical Memorandum, "The Effect of Simulated Lunar Dust on Absorptivity, Emissivity, and Operating Temperature on AZ-93 and Ag/FEP Thermal Control Surfaces, 2008

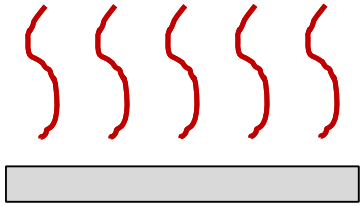
Coating properties need to align with EDS requirements.

Key coating properties for thermal radiators:

Solar Absorptance, α

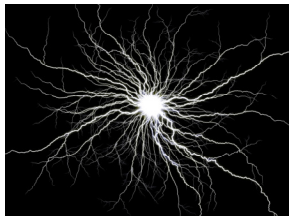


Emittance, ε



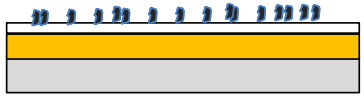
Key coating properties for EDS:

Electrically Insulative



Adhesion

Thin, particles close to the traces



The coatings have standard dry thicknesses which can be varied in some cases.

Coating Information from Literature:

Coatings	Manufacturer	Standard Dry Thickness (mm)	Solar Absorptance	Emittance
Solar White	KSC APL	0.127-0.254*	0.04	~0.90
AZ-93	AZ Technologies	0.089-0.165*	0.16	0.92
Aeroglaze A276	Socomore	0.038-0.051	0.26	0.88
Barium Sulfate Premix	Edmund Optics	0.5-0.6*	0.06	0.88
Thermal Bright	NeXolve	0.021	-	-
White Kapton	Dupont	0.013, 0.026	-	-

Solar White

White Kapton

A276

Thermal Bright

AZ-93

There are different ways to manufacture the EDS.

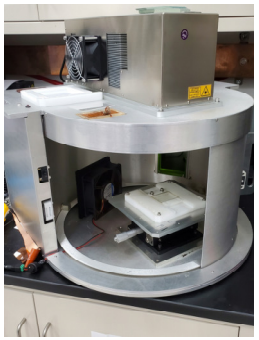
Base Material:

-sputter copper onto Kapton

-source copper-Kapton

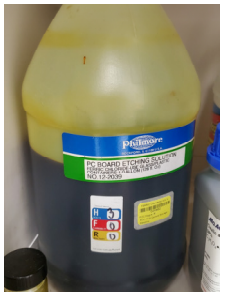
Manufacturing:

-laser etch pattern



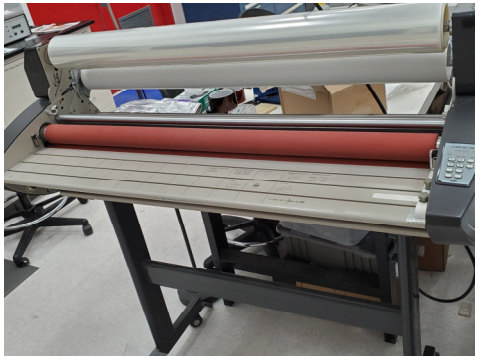
-use wax printer

-chemically etch pattern



Apply coatings:

-laminate Kapton/film coatings



-spray on paints

Previous dust removal testing has been done on some coatings.

Previous Testing:

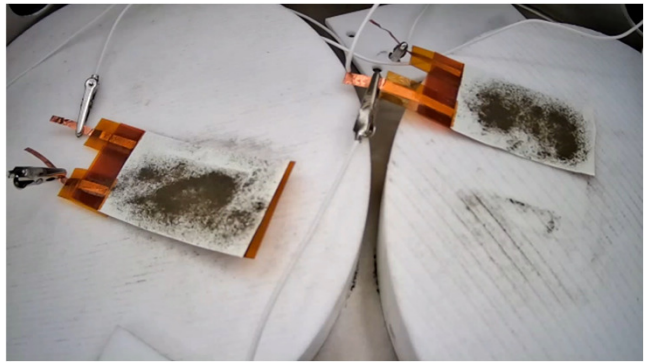
Solar White

R~ 100 GΩ in vacuum

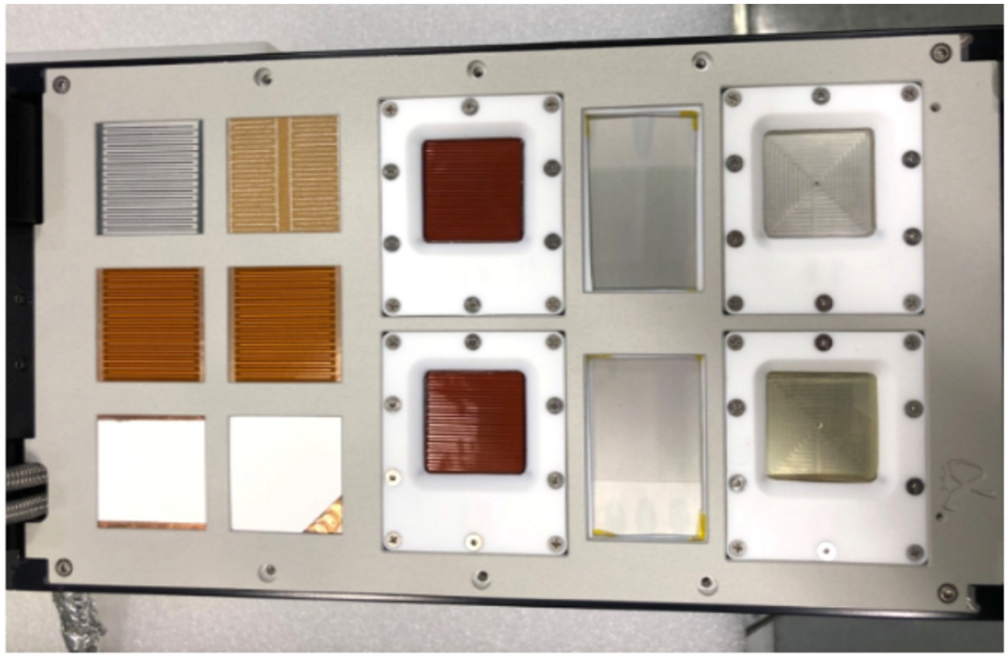
A276

AZ-93- no polarization

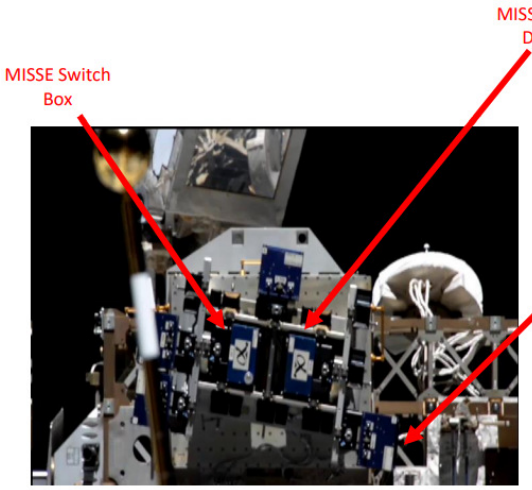
Thermal Bright



Some coatings have been exposed in space on MISSE flights.



MISSE-11 AZ-93

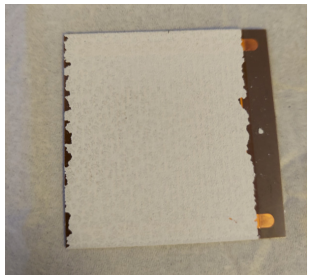


MISSE-15 Thermal Bright

Previous testing was inconsistent and did not include thermal considerations.

Current testing plan:

Test	Standard
Dust removal	ESPL SOP
Solar Absorptance	ASTM E903
Emittance	ASTM C1371
Thermal Vacuum	ESPL SOP



Iterative process

-Have consistent pattern and size EDS to test coating performance

-Take surface resistance, solar absorptance, emittance measurements before dust is applied

-Perform dust removal tests in air and vacuum

-Perform tests in thermal vacuum with and without dust to determine both the dust removal and the thermal coating performance

-If time allows, expose coatings to UV sources to observe any browning

The amount of dust cleared using the EDS will be determined through image intensity.

To determine amount of dust removal:

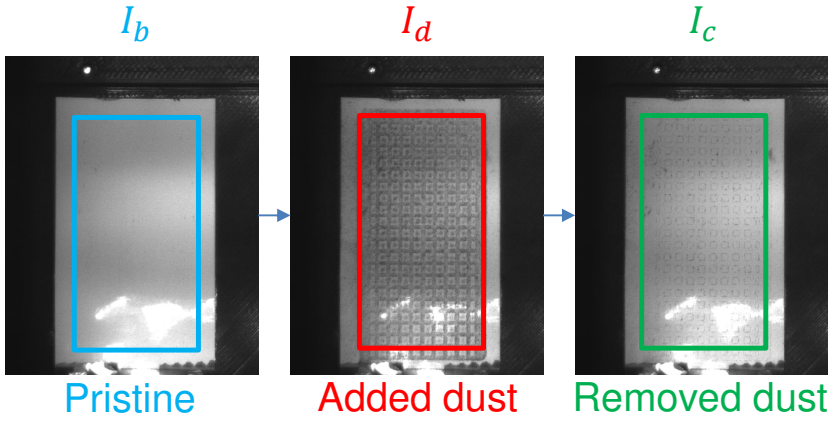
Clearing efficiency, $\eta = 1 - \frac{\text{amount of dust after clearing, } m_c}{\text{amount of dust when dirty, } m_d} = \frac{I_c - I_d}{I_b - I_d}$

I_b- baseline intensity

I_d- image with dust

I_c- image after clearing

Looking into taking solar absorptance and emittance measurements before, during, and after dusting process



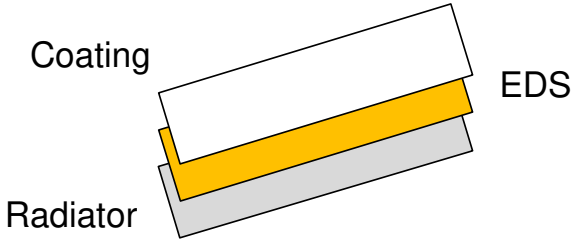
Future work will develop an EDS thermal radiator system with the best overall coating.

Conclusion:

-Seeking to develop an EDS+coating that can be used on thermal radiators

-Previous testing was not consistent and did not consider thermal properties

-Will compare multiple coatings using solar absorptance, emittance, dust removal, and thermal vacuum testing



Thank you!

Questions?