Background

• A new spray on coating has been demonstrated based on a broadband scatterer. This coating is very early in its development, but has shown promise as a solar reflector due to its high ultraviolet reflectivity. It is referred to as the solar radiation reflecting coating (SRRC) in this presentation.

• In this presentation the coating is applied to spray-on-foam insulation (SOFI). The reflectivity of bare foam and a piece of foam with white paint are compared to the reflectivity of the foam after being sprayed one, two, and three times with the SRRC coating.
Study Outline

• Two different coating studies were performed
  • Study 1 involved coating the top, “bumpy” surface of the SOFI
  • Study 2 involved coating the bottom, flat surface of the SOFI

• Samples were coated with KSC Solar Radiation Reflecting Coating (Formulation #9)

• Reflectance spectra were collected using a Jasco V-670 UV/Vis/NIR Spectrometer equipped with the ISN-723 Integrating Sphere attachment. The ISN-723 is a 60 mm barium sulfate coated integrating sphere with a 200 nm – 2500 nm spectral range. A white reflective tile (Spectralon) was used as a baseline material. Data was collected from 200 nm – 2400 nm.
STUDY 1
Top-Side Coating
Sample Preparation

• SOFI samples were cut into sections approximately 2” X 3” in size.
• 3 sections were randomly chosen for coating with the Solar Radiation Reflecting Coating (SRRC)
  • SOFI-1
  • SOFI-2
  • SOFI-3
• A SOFI sample coated with white paint was cut into a section approximately 2” X 2” in size.
Pre-Coating
1 Layer SRRC
Both the SRRC and the white paint have pooled in the surface recesses. These pooled regions are whiter and made comparison measurements difficult because the surface reflectivity varies.
1 Layer SRRC and White Paint Reflectance Spectroscopy

<table>
<thead>
<tr>
<th>Layer</th>
<th>Initial Weight</th>
<th>Final Weight</th>
<th>Coating Weight (1X)</th>
<th>Surface Area</th>
<th>Weight/SA</th>
</tr>
</thead>
<tbody>
<tr>
<td>SOF-1</td>
<td>1.6156g</td>
<td>1.8593g</td>
<td>0.2437g</td>
<td>0.0042m²</td>
<td>0.058kgm⁻²</td>
</tr>
<tr>
<td>SOF-2</td>
<td>1.6986g</td>
<td>1.9527g</td>
<td>0.2541g</td>
<td>0.0043m²</td>
<td>0.059kgm⁻²</td>
</tr>
<tr>
<td>SOF-3</td>
<td>1.9461g</td>
<td>2.1596g</td>
<td>0.2135g</td>
<td>0.0042m²</td>
<td>0.051kgm⁻²</td>
</tr>
</tbody>
</table>
2 Layers SRRC
Initial Weight | Final Weight | Coating Weight (2X) | Surface Area | Weight/SA
---|---|---|---|---
1.6156g | 1.9894g | 0.3738g | 0.0042m² | 0.089kgm⁻²
1.6986g | 2.0740g | 0.3754g | 0.0043m² | 0.087kgm⁻²
1.9461g | 2.3586g | 0.4125g | 0.0042m² | 0.098kgm⁻²
3 Layers SRRC
3 Layers SRRC and White Paint Reflectance Spectroscopy

**Initial Weight:** 1.9461g

**Final Weight:** 2.7262g

**Coating Weight (3X):** 0.7801g

**Surface Area:** 0.0042m²

**Weight/SA:** 0.19kgm⁻²

**Solar Absorbance**
- Uncoated SOFI: 49%
- White Paint SOFI: 34%
- SOFI-3 Coated X3: 30%

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**Graph:**
- SOFI-3
- SOFI-3 Coated
- SOFI-3 Coated X2
- SOFI-3 Coated X3
- White Paint

**Reflectance (%)**

<table>
<thead>
<tr>
<th>Wavelength (nm)</th>
<th>200</th>
<th>400</th>
<th>600</th>
<th>800</th>
<th>1000</th>
<th>1200</th>
<th>1400</th>
<th>1600</th>
<th>1800</th>
<th>2000</th>
<th>2200</th>
<th>2400</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reflectance (%)</td>
<td>90</td>
<td>80</td>
<td>70</td>
<td>60</td>
<td>50</td>
<td>40</td>
<td>30</td>
<td>20</td>
<td>10</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

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**Tables:**

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial Weight</td>
<td>1.9461g</td>
</tr>
<tr>
<td>Final Weight</td>
<td>2.7262g</td>
</tr>
<tr>
<td>Coating Weight (3X)</td>
<td>0.7801g</td>
</tr>
<tr>
<td>Surface Area</td>
<td>0.0042m²</td>
</tr>
<tr>
<td>Weight/SA</td>
<td>0.19kgm⁻²</td>
</tr>
</tbody>
</table>
Spraying on the uneven top side of the SOFI samples yields a non-uniform coating which is difficult to characterize, so all of the data shown above is subject to positional (i.e. placement of the sample in the reflectometer) error.

Also, additional layers improve the performance, but not as much as expected, possibly due to the coating running off of the peaks and into the recesses. In other words, the absorption of the uncoated SOFI peaks are limiting the performance of the SRRC.

The solar absorbance numbers were calculated using a 5778 K blackbody model of the Sun. This is reasonable, but under-estimates the Sun’s UV emission. However, the Spectralon standard has UV absorbance and results in an overestimate of the effectiveness of coatings in the ultraviolet. Of these two effects, the Spectralon is likely dominant, so the UV effectiveness of the new SRRC coating is overestimated by the spectra shown above.
Concerns: SOFI-3

Potential Issue with Coating Flaking Off When Too Thick

The SRRC adheres to the SOFI but can be rubbed off. In depressions where it is thick it can flake off. More work is needed to improve the coatings strength, but some improvement can be made by applying it to a more even surface.
STUDY 2
Bottom-Side Coating

A more uniform surface
Sample Preparation

• SOFI samples were cut into sections approximately 2” X 3”
• 3 sections randomly chosen for coating with Solar Radiation Reflecting Coating (SRRC)
  • SOFI-4
  • SOFI-5
  • SOFI-6
# 1 Layer SRRC Reflectance Spectroscopy

<table>
<thead>
<tr>
<th></th>
<th>Initial Weight</th>
<th>Final Weight</th>
<th>Coating Weight (1X)</th>
<th>Surface Area</th>
<th>Weight/SA</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1st Sample</strong></td>
<td>2.1697g</td>
<td>2.6011g</td>
<td>0.4314g</td>
<td>0.0046m²</td>
<td>0.094kgm⁻²</td>
</tr>
<tr>
<td><strong>2nd Sample</strong></td>
<td>1.7438g</td>
<td>2.1887g</td>
<td>0.4449g</td>
<td>0.0043m²</td>
<td>0.10kgm⁻²</td>
</tr>
<tr>
<td><strong>3rd Sample</strong></td>
<td>1.6329g</td>
<td>2.0716g</td>
<td>0.4387g</td>
<td>0.0042m²</td>
<td>0.10kgm⁻²</td>
</tr>
</tbody>
</table>

![Graphs showing reflectance spectra for SOFI Flat Blank and SOFI-4, SOFI-5, SOFI-6 Coated samples.](image-url)
2 Layers SRRC

SOFI-4 Coated X2

SOFI-5 Coated X2

SOFI-6 Coated X2
2 Layers SRRC Reflectance Spectroscopy

Solar Absorbance
Uncoated: 36%
SOFI-4 Coated X2: 6.7%

<table>
<thead>
<tr>
<th>Initial Weight</th>
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<th>Coating Weight (2X)</th>
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</tr>
</thead>
<tbody>
<tr>
<td>2.1697g</td>
<td>3.0609g</td>
<td>0.8912g</td>
<td>0.0046m²</td>
<td>0.194kgm²</td>
</tr>
<tr>
<td>1.7438g</td>
<td>2.7370g</td>
<td>0.9932g</td>
<td>0.0043m²</td>
<td>0.231kgm²</td>
</tr>
<tr>
<td>1.6329g</td>
<td>2.5750g</td>
<td>0.9421g</td>
<td>0.0042m²</td>
<td>0.153kgm²</td>
</tr>
</tbody>
</table>
Conclusions

• SRRC coated samples showed improved reflectance in the UV region compared to uncoated and white paint coated SOFI samples.

• Reflectance improved with each additional application of SRRC but there was sample to sample variation.

• Neither white paint nor the SRRC could be applied evenly over a non-uniform surface.

• A moderately thick uniform layer of SRRC can achieve impressive solar reflectivity results.