

Moisture-Permeable Encapsulation for Rohacell Foam

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Motivation

- Rohacell© 31HF HT foam is a candidate material for spacecraft thermal applications for cryogenic missions.
- **Problem:** open cell foam sheds particulate and retains a significant amount of water.

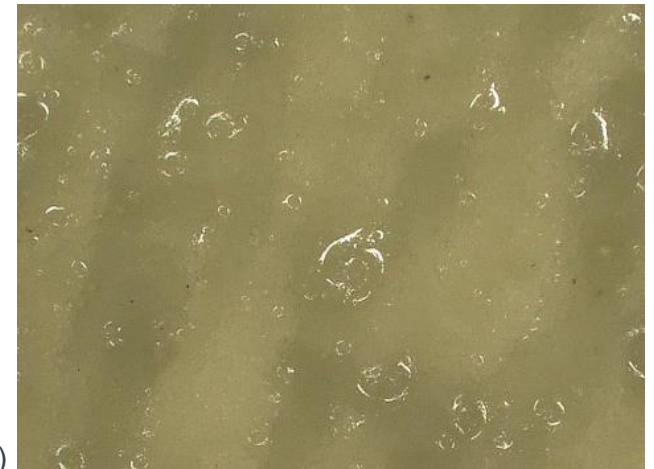
Rohacell 31 HF: TML = 3.36%, CVCM = 0.03%, WVR = 2.62%

Contamination mitigations must be employed with the following goals:

- 1) **Encapsulate foam to eliminate particulate shedding.**
- 2) **Encapsulating material needs to be water-vapor permeable.**



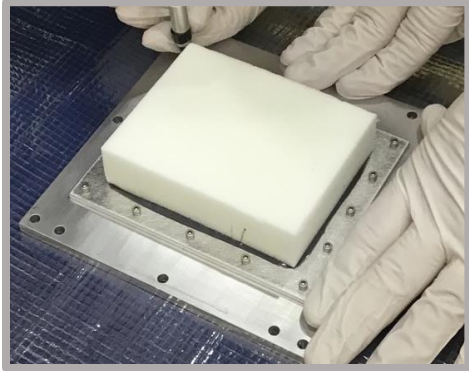
a)



b)

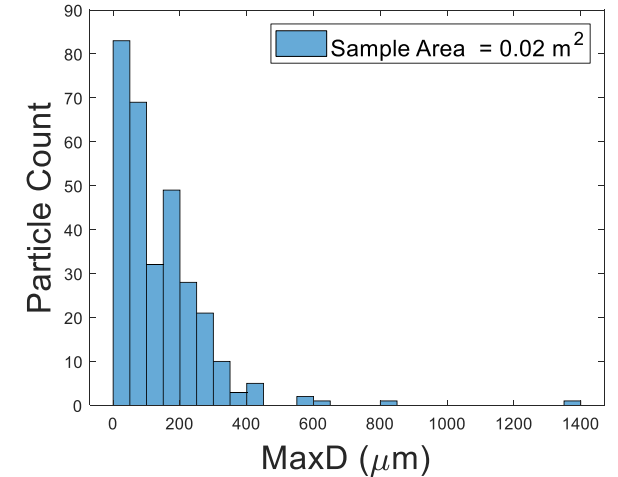
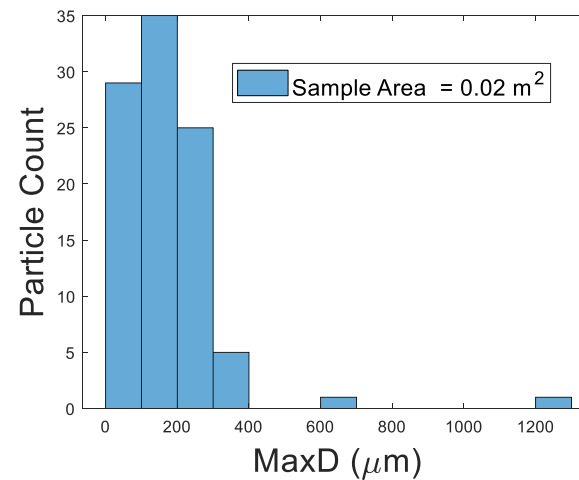
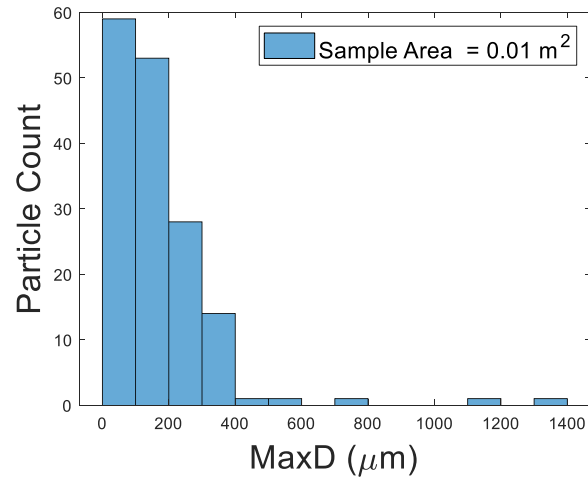
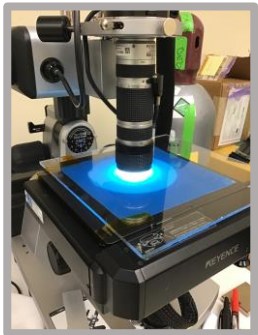
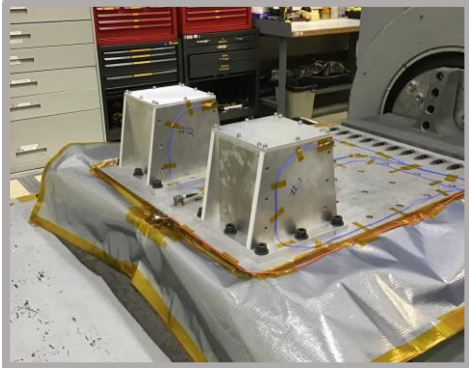
Microscope images of the potential foam encapsulation methods a) Arathane 5750 and b) EA-9396.

Particulate Shed from Uncoated Foam



Rohacell thermal foam - concern for particulate contamination

- Sheds significantly when handled
- Generates particulate contamination under vibro-acoustic loads and aging
- Vibe Test - GSFC GEVS random levels for 2 min/axis



Encapsulation of the thermal foam is the simplest approach to mitigate the concern.

Test Flow

Two coating options were explored:

1. Arathane 5750 Conformal Coat

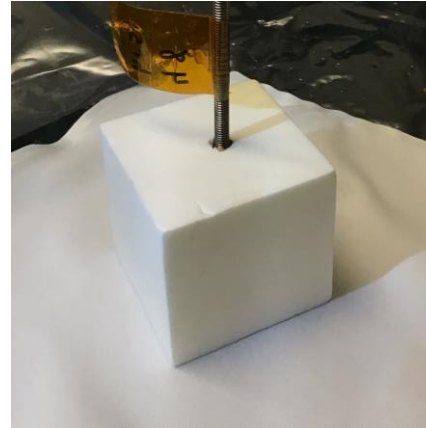
Applied per standard process

Cured for 48 hours at 65°C in air

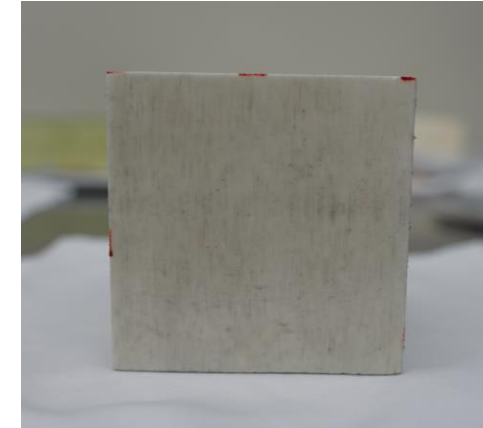
2. EA-9396 Resin

Brush coated onto sample

Cured for 2 hours at 49°C in air

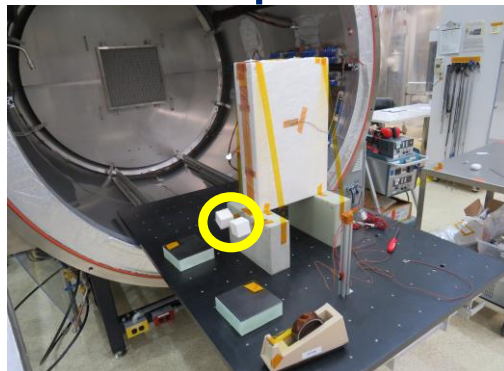
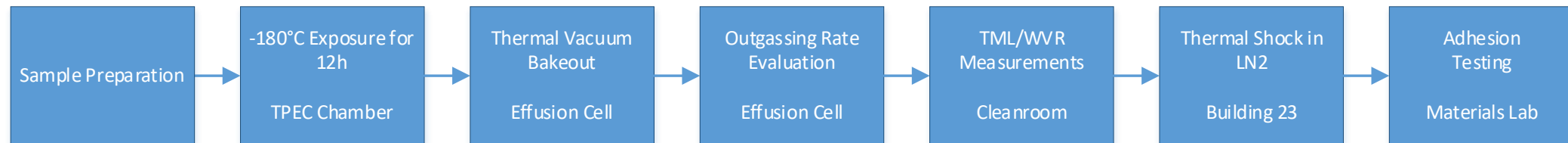


Arathane 5750 Conformal Coat



EA-9396 Resin

Both samples underwent the following test flow:

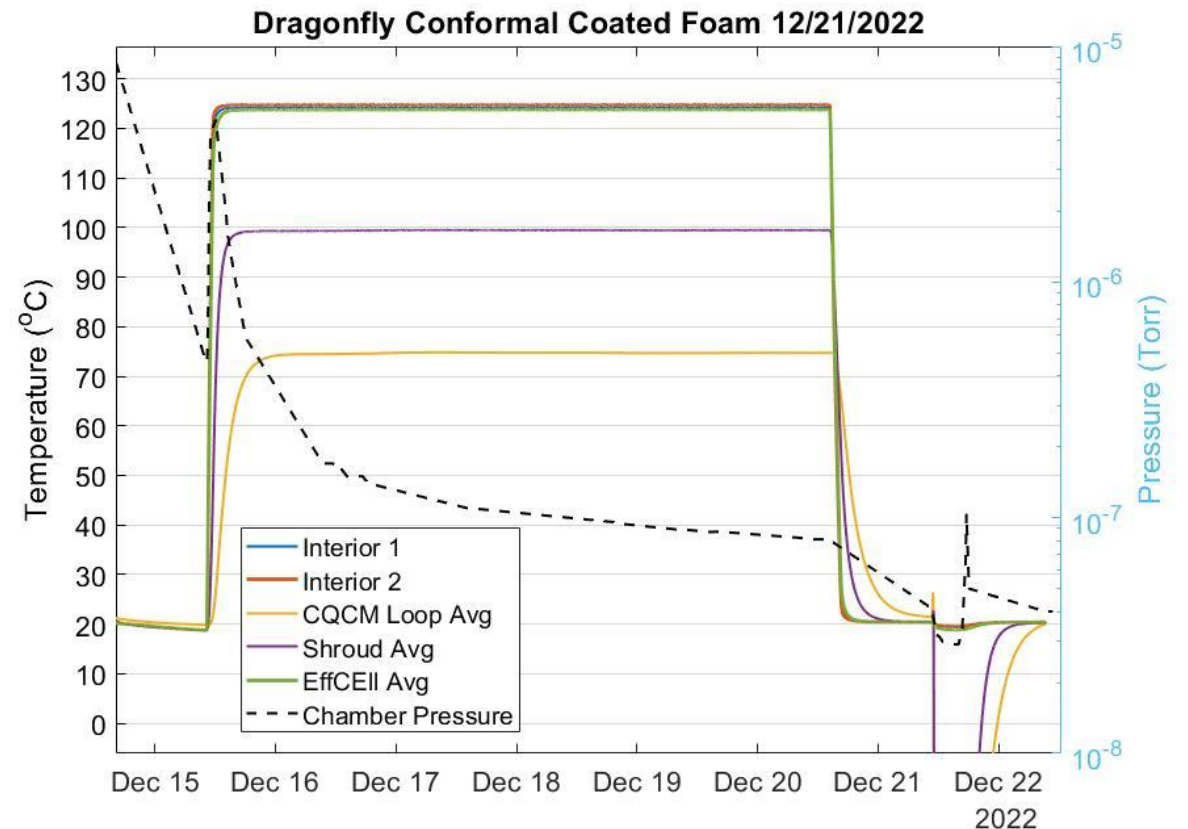


Thermal Vacuum Bakeout and Effusion Cell

- APL Large Effusion Cell is a thermally dynamic test setup for precisely quantifying and characterizing outgassing from box-level spaceflight hardware
- Trapdoor in the rear of the cell is open for hardware bakeout and then slid closed to measure outgassing
- Coated foam samples underwent bakeout at +125°C followed by outgassing measurements at +20°C
- Difference between outgassing measured at -140°C versus -100°C on CQCM is due to any water still outgassing from the samples

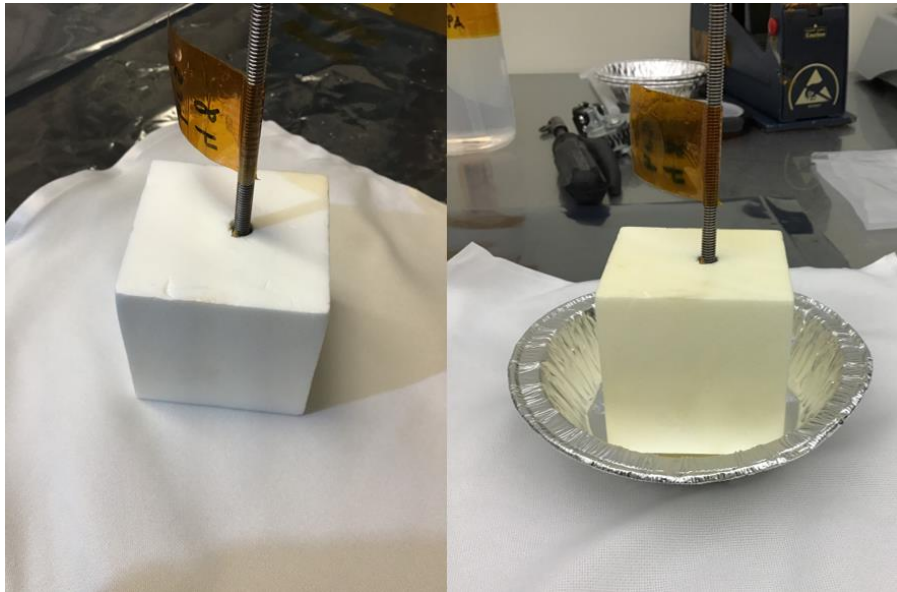


Resin-coated foam inside effusion cell

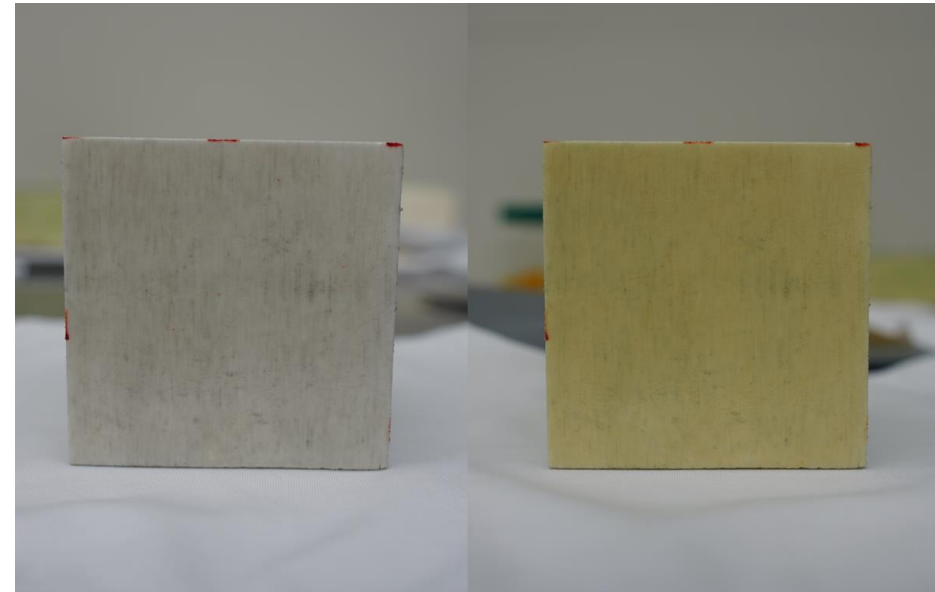


General TVAC Performance and Compatibility

- No significant adverse effects on chamber pump-down speed were observed
- Significant discoloration observed in both samples (as expected)
- No cracking or delamination observed in coatings after TVAC exposure



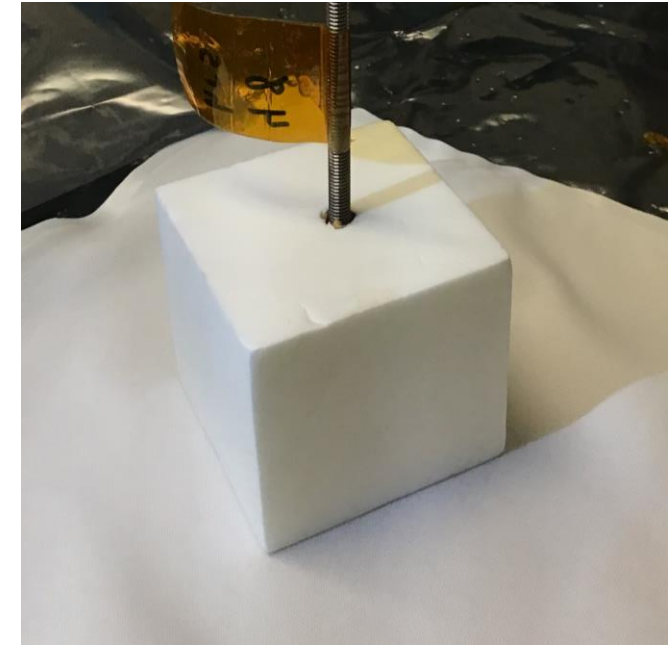
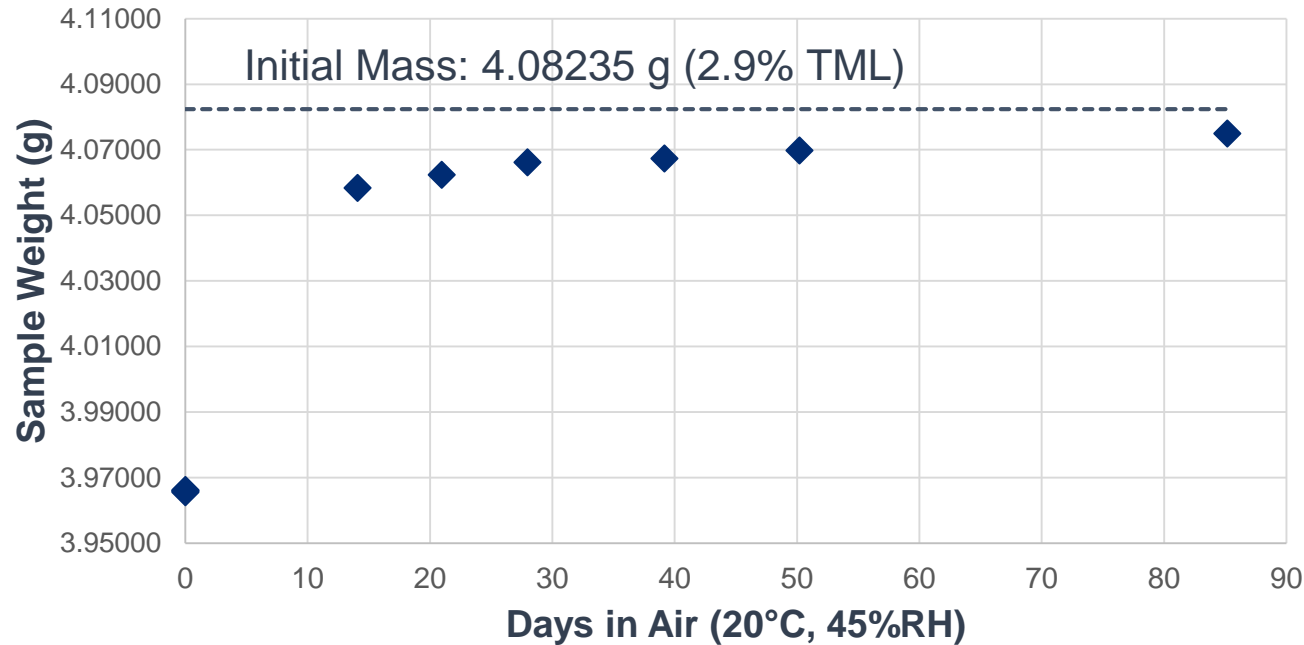
Arathane 5750 coated sample before (left) and after (right) TVAC



EA-9396 coated sample before (left) and after (right) TVAC

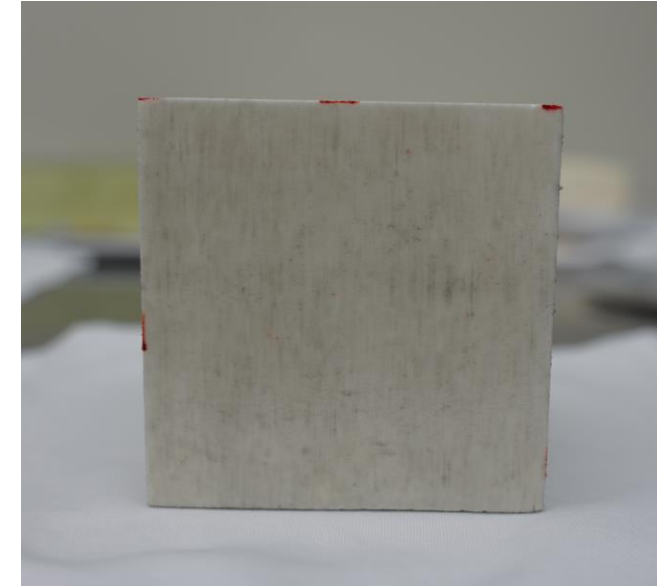
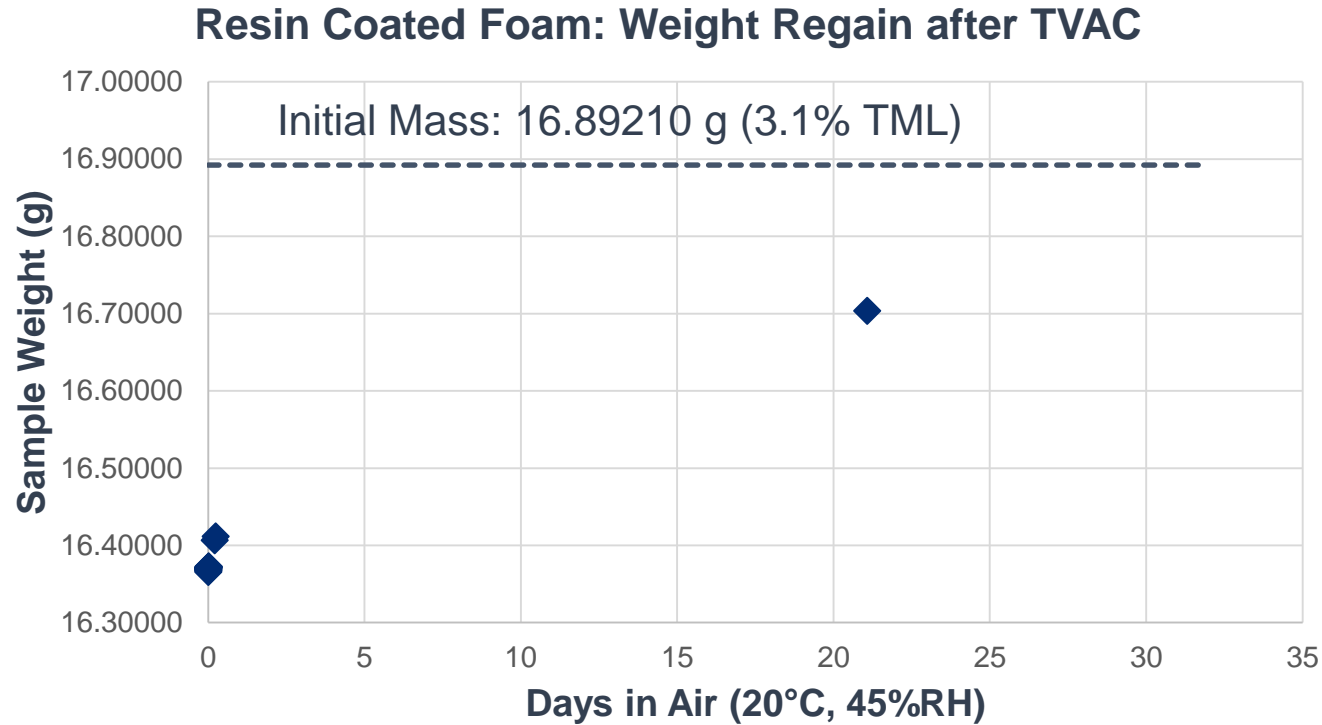
Encapsulated Foam – Arathane 5750

Conformal Coated Foam: Weight Regain after TVAC



CQCM Collection Temp (°C)	Outgassing Rate (g/cm ² /s)	Outgassing Rate Error (g/cm ² /s)	Chamber Pressure (Torr)	CQCM Delta Frequency (Hz/hr)
-80	3.1 x 10 ⁻¹³	0.3 x 10 ⁻¹³	3.2E-8	2.8
-140	2.9 x 10 ⁻¹³	0.4 x 10 ⁻¹³	2.9E-8	2.6

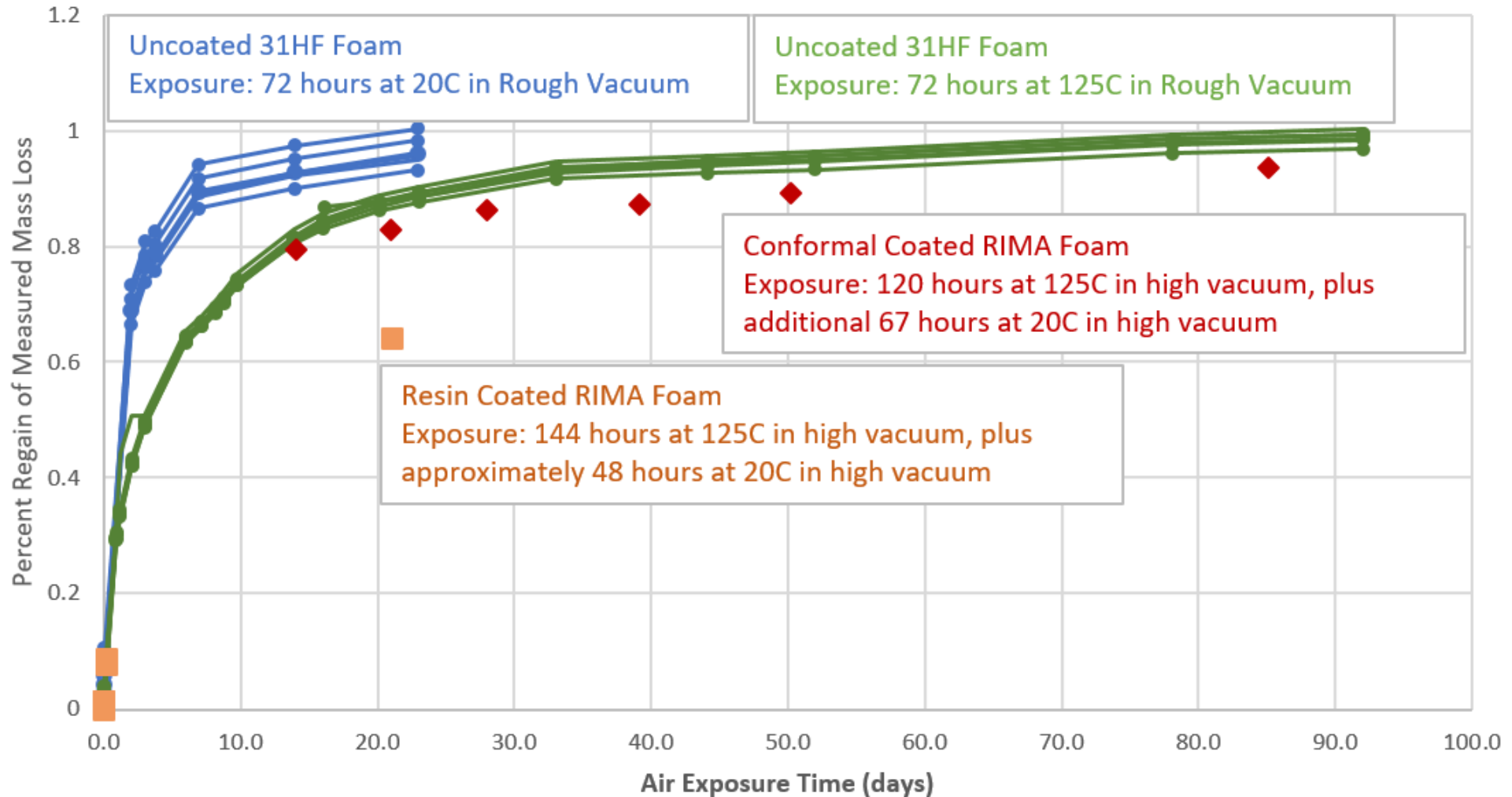
Encapsulated Foam – EA-9396



CQCM Collection Temp (°C)	Outgassing Rate (g/cm ² /s)	Outgassing Rate Error (g/cm ² /s)	Chamber Pressure (Torr)	CQCM Delta Frequency (Hz/hr)
-100	6.1 x 10 ⁻¹⁴	8 x 10 ⁻¹⁵	2.6E-8	2.1
-140	5.2 x 10 ⁻¹⁴	7 x 10 ⁻¹⁵	2.7E-8	1.8

Water Regain Behavior Comparisons

Weight Regain After Vacuum Exposure



Tape Adhesion Results

- ASTM D3359 tape pull testing after TVAC and cold thermal shocking produced clean results
- No visible change or mechanical failure of the coating on the sample after tape pull completed
- No coating remnants left behind on the tape after the pull

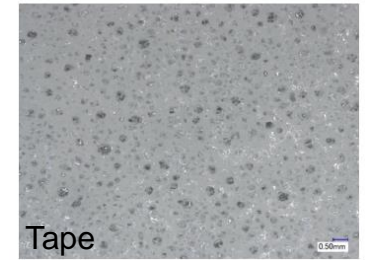
Arathane 5750:



Pre Tape Pull

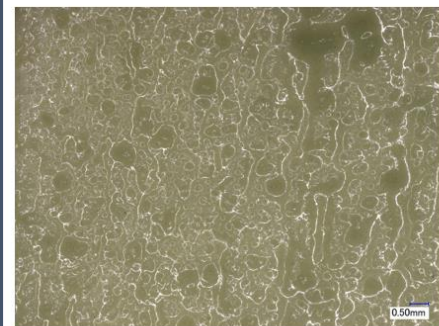


Post Tape Pull

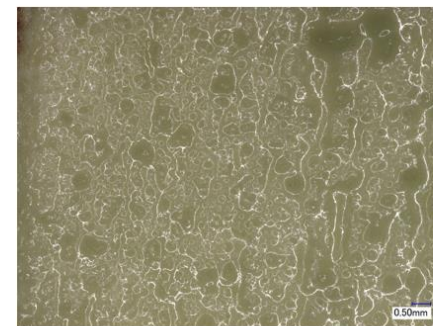


Tape

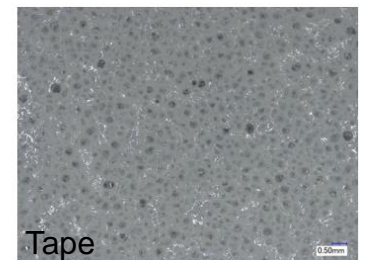
EA-9396:



Pre Tape Pull



Post Tape Pull



Tape

Conclusions

	Sample Weight	Bakeout Time	Bakeout Temperature	Bakeout Pressure	%TML
Arathane 5750 Conformal Coat	~ 4g	120 hours	125°C	<1E-5 Torr	2.9
EA-9396 Resin	~16g	144 hours	125°C	<1E-5 Torr	3.1
<i>Bare Rohacell 31HF Foam (1)</i>	<i>0.1-0.3 g</i>	<i>24 hours</i>	<i>125°C</i>	<i>< 5E-5 Torr</i>	<i>3.36</i>

(Reported E595)

- TML and WVR for bare Rohacell foam closely matches values for Arathane 5750 and EA-9396 resin coated samples, indicating water is unhindered by presence of the coating
- Testing after vacuum and thermal exposure shows that mechanical integrity of the coating is maintained and no additional contamination is generated

Both Arathane 5750 and EA-9396 are viable coatings to mitigate particulate contamination concerns and still allow for water outgassing.

(1) Data reference GSFC29884 from outgassing.nasa.gov



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