

Enthone Solder Mask Performance in NASA OUTGASSING Testing

Introduction

The requirements for materials used in space flight applications are very strict. The intense vacuum of space can cause polymers to outgas or volatilize. This outgassing matter may condense on other surfaces and cause system problems or failures.

A technique, accepted by the National Aeronautics and Space Administration (NASA), has been developed to measure the outgassing potential of materials when exposed to a vacuum environment. Two parameters are measured: Total Mass Loss (TML) and Collected volatile Condensable Materials (CVCM). TML is the total mass of matter outgassed or lost from a specimen that has been exposed to a vacuum at an elevated temperature. CVCM is the quantity of outgassed matter that condenses on a collector plate. Both values are expressed as a percent of the original specimen mass.

A maximum of 1.0% TML and 0.1% CVCM is considered acceptable by NASA for most space applications.

Test Results

<u>Product</u>	<u>Final Cure Schedule</u>	<u>TML, %</u>	<u>CVCM, %</u>
<u>Liquid Photoimageable Solder Masks</u>			
ENPLATE® DSR-3241 ¹	60 minutes @ 149°C (300°F)*	0.94	0.01
ENPLATE® DSR-3300 ²	120 minutes @ 160°C (320°F)*	0.74	0.07
ENTHONE® DSR-3241 Q ²	120 minutes @ 160°C (320°F)*	0.83	0.08
<u>Thermal Cured Solder Masks</u>			
SR1000 ²	60 minutes @ 149°C (300°F)	0.65	0.01
SR2020/Catalyst 10	15 minutes @ 149°C (300°F)	0.59	0.03
SR2030/Catalyst 11 ²	15 minutes @ 149°C (300°F)	0.55	0.09
<u>Two Component Legend Inks</u>³			
50-100 White/Catalyst 9	30 minutes @ 149°C (300°F)	0.64	0.01
50-700 Black/Catalyst 9	30 minutes @ 149°C (300°F)	0.74	0.01
50-771R/Catalyst 9	30 minutes @ 149°C (300°F)	0.53	0.07
<u>Two Component Marking Inks</u>³			
M-9-N White/Catalyst B-3	30 minutes @ 149°C (300°F)	0.51	0.04
M-0-N Black/Catalyst B-3	30 minutes @ 149°C (300°F)	0.50	0.01
M-0-N Black/Catalyst 20/A ²	30 minutes @ 149°C (300°F)	0.58	0.07
M-0-NC Black/Catalyst B-3	30 minutes @ 149°C (300°F)	0.61	0.13
M-2-N Red/Catalyst 45 ¹	4 hours @ 149°C (300°F)	0.40	0.02
M-5-N Green/Catalyst 45 ¹	4 hours @ 149°C (300°F)	0.44	0.02

¹ Testing performed by Goddard Space Flight Center in Greenbelt, MD.

² Testing performed by NuSil Technology, an independent laboratory in Carpinteria, CA.

³ The black and white ink/catalyst combinations were selected for testing because they are representative of the other colors in each series. Similar Test Values can be expected.

Testing is performed according to the requirements of ASTM-E-595 at a temperature of 125°C for 24 hours in a vacuum of 10⁻⁶ torr. The condensable materials were collected at 25°C within the same system.

NOTE: Cure times, temperature and coating thickness have a major impact on outgassing values. It is imperative that the coating is completely cured and all solvents eliminated.

Legend and marking inks, when tested with ambient cure catalysts, did not meet the requirements. Any deviations from the listed cure schedules should be verified for compliance.

Process Recommendations

General processing recommendations to achieve NASA outgassing requirements:

- 1) Be certain that laminate to be used in this application is fully cured and dry.
- 2) Avoid process delays to prevent moisture regain.
- 3) Use the minimum solder mask coating thickness which will achieve end-product performance requirements.

* Product specific recommended process conditions:

<u>Material</u>	<u>Step</u>	<u>Required Parameters</u>
DSR-3241	Coat	Minimum Acceptable Thickness
	De-bubble	20 minutes @ ambient temperature
	Tack Dry	90 minutes @ 70°C (160°F)
	Expose	SST 14
	Develop	1% Na ₂ CO ₃ @ 35°C (95°F)
	UV Bump	4 joules
	Final Thermal Cure	60 minutes @ 149°C (300°F)
DSR-3300 & DSR-3241 Q	Coat	Minimum Acceptable Thickness
	De-bubble	20 minutes @ ambient temperature
	Tack Dry	90 minutes @ 70°C (160°F)
	Expose	SST 14
	Develop	1% Na ₂ CO ₃ @ 35°C (95°F)
	UV Bump	4 joules
	Final Thermal Cure	120 minutes @ 160°C (320°F)