

## CERAKOTE OUTGAS TEST

We submitted samples of C-138 Jet Black and LR-100 Black of Cerakote coatings to Element Laboratories, Inc., a third-party testing facility. This test was to measure the outgassing of the coatings in a vacuum environment to support Cerakote's usage in the space industry.

### Test Conducted:

ASTM E595-15 Standard Test Method for Total Mass Loss and Collected Volatile Condensable Materials from Outgassing in a Vacuum Environment

### Cerakote Coatings Tested:

- Specimen ID: C138 (Cerakote C-138 Jet Black)
- Specimen ID: LRB P38 (Cerakote LR-100 LR Black)

### Conclusion:

- Both coatings tested **meet** the ASTM E595-15 requirements.

**Test Results: See below**



**TEST REPORT  
EAR-CONTROLLED DATA**

In account with  NIC INDUSTRIES 7050 SIXTH STREET WHITE CITY, OR 97503	Date	6/13/2023	Page 1 of 5 Pages
	W. O. No.	T 63930	P. O. No. 0025854
	Identification	As noted	Shipper N/A

Revision Letter:	Original Issue	Issue Date:	6/13/2023
Prepared By:	Hosein Shahnazi	Approved by:	See Below

- IDENTIFICATION : Two (2) lots of material, identified as C138; and LRB P38, were submitted for testing per NIC Industries Purchase Order No. 0025854.
- SPECIFICATIONS : ASTM E595-15 (2021), Sect. 1.5
- REFERENCES :
  1. NIC Industries Purchase Order No. 0025854, dated 5/26/2023.
  2. Element Los Angeles Quotation No. ELO0034743Q/0, dated 4/11/2023.
  3. Email Correspondence Between NIC Industries and Element LA dated 5/24/2023 to 5/26/2023.
  4. ASTM E595-15 (2021), "Standard Test Method for Total Mass Loss and Collected Volatile Condensable Materials from Outgassing in a Vacuum Environment".

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TEST METHODS

**A. OUTGASSING**

The 100-300 mg test specimen was preconditioned at 23°C and 50 % relative humidity for 24 hours in a preformed, degreased preweighed aluminum container. The container with specimen was reweighed following preconditioning and placed into the test apparatus specimen heating compartment. The test apparatus was sealed and the specimen was subjected to a vacuum of at least  $7 \times 10^{-3}$  Pa ( $5 \times 10^{-5}$  torr) and a temperature of 125°C. Any evolved gases vaporized from the heated specimen streaming from the specimen compartment are condensed and collected on a preweighed chromium-plated collector plate maintained at 25°C. Each specimen compartment and collector plate combination is physically isolated from other specimens by a compartmented separator plate to prevent cross contamination.

The test apparatus was cooled to ambient laboratory temperature after 24 hours at vacuum and the vacuum chamber was repressurized with dry nitrogen gas. The specimen and the collector plates were removed and weighed. The percentage TML and percentage CVCM were calculated as directed in ASTM E595 using the pre- and post- vacuum exposure specimen mass values.

The WVR was determined following a specimen post- conditioning for 24 hours at 23°C and 50 % relative humidity to permit sorption of water vapor. The specimen mass after the post- exposure was measured and the WVR value was calculated as directed in ASTM E595.

**SUMMARY:**

Specimen ID	Testing Conducted	Test Value		Requirement	Results
C138	ASTM E595-15 (2021) Outgassing (%)	TML	0.16	1.00 MAX	<i>Meets Specification</i>
		CVCM	0.00	0.10 MAX	<i>Meets Specification</i>
		WVR	0.03	REPORT	Information Only
LRB P38		TML	0.14	1.00 MAX	Meets Specification
		CVCM	0.01	0.10 MAX	<i>Meets Specification</i>
		WVR	0.03	REPORT	Information Only

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Page 3 of 5 Pages

Date 6/13/2023

W.O. No. T 63930

REMARKS: 1. Test results are submitted herein for client evaluation.

Respectfully submitted,

Hosein Shahnazi

Department Manager

Element Materials Technology Los Angeles

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TEST REPORT
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OUTGASSING per ASTM E595

Customer: NIC Industries
Material ID: C138
Part Number:
Lot/Batch No.:

Order No.: T63930
Date: 6/6/2023 - 6/9/2023
Serial No.
Other ID:

Specification: ASTM E595-15 (2021)
Method: ASTM E595-15 (2021)
Lab Temp °C: 23.5

Humidity %RH: 44.8
Technician: BS

Pre Test Conditioning: 23°C and 50% RH for 24 hours
Post Test Conditioning: 23°C and 50% RH for 24 hours
Drying Chamber Start Date/Time: 6/6/2023 at 5:50 pm
Vacuum Chamber Start Date/Time: 6/7/2023 at 2:10 pm

End Date/Time: 6/7/2023 at 10:00 am
End Date/Time: 6/8/2023 at 2:10 pm

Test Parameters: Outgas for 24 hours at 125°C under vacuum of 5 x 10-5 or less Tor

Collector Plate Parameter: 25°C

Table with 7 columns: Test No., 1, 2, 3, Blank, Average, Required. Rows include Initial Collector Mass, Initial Boat Mass, Initial Boat + Specimen Mass, Pre Test Conditioned Boat + Specimen Mass, Post Outgassing (Cooled to RT) Boat + Specimen Mass, Post Outgassing Collector Plate Mass, Water Vapor Regain Boat + Specimen Mass, Total Mass Loss (% TML), Collected Volatile Condensable Materials (%CVMC), and Water Vapor Regain (% WVR).

The above test results:

Meet requirements of the specification as noted in accordance with

ASTM E595 Section 1.5, "The criteria used for acceptance and rejection of materials shall be determined by the used and based upon specific component and system requirements. Historically, TML of 1.00% and CVMC of 0.10% have been used as screening levels for rejection of spacecraft materials."

Table with 3 columns: EQUIPMENT, EC#, CAL DUE. Rows include Microbalance, Vacuum Gage, Temperature Controller, and Conditioning Chamber Internal Sensor.

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TEST REPORT
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OUTGASSING per ASTM E595

Customer: NIC Industries
Material ID: LRB P38
Part Number:
Lot/Batch No.:

Order No.: T63930
Date: 6/6/2023 - 6/9/2023
Serial No.
Other ID:

Specification: ASTM E595-15 (2021)
Method: ASTM E595-15 (2021)
Lab Temp °C: 23.5

Humidity %RH: 44.8
Technician: BS

Pre Test Conditioning: 23°C and 50% RH for 24 hours
Post Test Conditioning: 23°C and 50% RH for 24 hours
Drying Chamber Start Date/Time: 6/6/2023 at 5:50 pm
Vacuum Chamber Start Date/Time: 6/7/2023 at 2:10 pm

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Test Parameters: Outgas for 24 hours at 125°C under vacuum of 5 x 10-5 or less Tor

Collector Plate Parameter: 25°C

Table with 7 columns: Test No., 1, 2, 3, Blank, Average, Required. Rows include Initial Collector Mass, Initial Boat Mass, Initial Boat + Specimen Mass, Pre Test Conditioned Boat + Specimen Mass, Post Outgassing (Cooled to RT) Boat + Specimen Mass, Post Outgassing Collector Plate Mass, Water Vapor Regain Boat + Specimen Mass, Total Mass Loss (% TML), Collected Volatile Condensable Materials (%CVMC), and Water Vapor Regain (% WVR).

The above test results:

Meet requirements of the specification as noted in accordance with

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