# NALSUN-NG

Environment-Friendly NALSUN Next Generation Coating (NALSUN-NG) for Solar Thermal Applications



Industrial Process Heat



National Aerospace Laboratories CSIR NAL Bangalore - 560017

NALSUN-NG PANEL

Desalination



CSIR-National Aerospace Laboratories Bangalore - 560 017







# NALSUN-NG

**Preamble:** Solar energy is an unlimited source of renewable energy, which can be utilized in energy production to generate both heat and electricity. India is a tropical country, and solar energy is abundant throughout the year. Solar thermal conversion is the simplest and most direct method of harnessing solar energy. In the late 1980s, CSIR-NAL developed NALSUN solar absorber coating technology for domestic water heater applications using the electrodeposition method. However, the coating bath is carcinogenic owing to the presence of hexavalent chromium, and its disposal is a challenge. In addition, there is a need to develop a cost-effective, eco-friendly, and easily scalable coating technology that is not available in the country.

ALSUN-NG PANEL





**Current Level of Technology:** CSIR-NAL has developed an eco-friendly sprayable spectrally selective coating for domestic solar water heater applications. The spectrally selective coating consists of two layers: an absorber layer and an inorganic protective layer. The coating was sprayed manually on 2 m long Al fins, and a solar water heater panel was fabricated. The photothermal conversion efficiency of the NALSUN-NG panel is 70% with heat loss coefficient of 4.36 W/m<sup>2</sup>C. The coating has qualified all the environmental tests as per the International Energy Standards. Based on the test results, the service life of the coating is expected to be more than 20 years.

## NALSUN-NG coating on aluminum substrates



Coupon Level



Aluminum Fin (2 m x 0.1 m)



# NALSUN-NG

## **Salient Features of NALSUN-NG Coating**

- Non-hazardous raw materials
- New absorber coating formulation
- New inorganic protective layer formulation
- Environment-friendly water borne coating
- High solar absorptance (0.91-0.93)
- Low thermal emittance (0.21-0.30) at 82°C
- Thermally stable in air at 175°C for 600 h  $\,$
- Developed on metal substrates (Al, GI, etc.)
- No volatile organic compounds
- RoHS and REACH compliant
- Uses very simple effluent treatment process
- Easily scalable and cost-effective spray process

# Humidity RoHS, REACH, and VOC Tests Qualified Adhesion Test UV Irradiation Corrosion Resistance

**Humidity Report** 

## **ISRO Report**

### **NALSUN-NG Panel**

URSC-(TR-2)52	Issue No. A Date: 17-02-2020	Page 1 of 1				C Amile	the start afteritfine anatalarray without
G. URSC Test Report for Thermal I	farameter Measurement	Revision 02 Date: 01-02-2022				1 3150	ीय वांतरिक्ष प्रयोगशाला
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to Requisition given by	Dr. Hansh C. Darshilia Staffaca Engineering Divis	legt				1	Test Report Ref: NAL-ACD-ETF(Int.)/08/2022/674)
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					- Ref Tes	No Larticle Part & SI No	Request received by email dated 26.04.2022 Solar Absorber Coating
Fert Semple Package Sub-system detail	Test un	ple 1929	2 m		Úles I	allocide ha	Sample No 1783 and 1784, Qty 1 No (each) Surface Engineering Distance (CSID MA)
	1				Typ	in of least	Humidity Test
Objective at the test theread increases	Management of surface				 Tes	a profilia	Temperature : 40°C Humidity 95 % RH
inclosed	Jujof Solar absorber com	n so Al substate:					Total duration: 600 Hrs continuously
Competiature saries of mensionencests	Measurement at - 20 its Characterization and mu	aler ambient condition) diffection of the newly			Ref	bakhrata	International Energy Agency Task 27
H End use of test results	developed Solar absorber of	pating.	1.00		DN	Imper used	Climatic Chamber (M's Vijayalakshmi Industries)
b) Detailed card use of the test sample: pickingst rab-cysterr in the project unwarraft/launch vehicle	Barghierte, for high solar e applications, an a new	a is reacted by CSBC-NAL https://www.science.com/ development. Hence, the		114 1	Call	bration due t Conducted on	09.12.2022 10.05.2022 to 04.06.2022
	<ul> <li>Louising is applied on test s</li> <li>Louis indy (it) measures</li> </ul>	atiples for measurements.)			. Ins	t Procedure	
Equiption such for measurements	Instrument Emission Medel: AEI & RDF Make: Devices and 3 Solar absorptions (ns) Instrument: Solar Sg Model: SSR-II, SI, N Make: Devices and 3	ieur N. No.: #16 ierrices Coopuny, USA reamentes ceinen Reflectomote o, 085 ierrices Company, USA			The prof	Solar Absorber Coati lie was configured in rence standard. Switc orber Coating specim	rgo specimen was placed inside this climatic chamber and live the controller as per the test profile specified by the and user hed ON the chamber and carried out the humidity last, the S en was removed from the chamber after completion of the test
Test methodology? president	Solar alsorphils (ock A Ambient condition:	STREC   SIM AL			Dba	ervations	
Test costingen	Parvate - 1 htt		1			No. Visual deterioration	was observed after the test
St. No. Test sample details 1 Test sample (929 Uncertainty in the transverol parameters	Emissivity (1)	Salar absorptivity (a.) (KM1.5) 1 = 10.95 Television			I) I ISe	Coul massal	(Salva Kumar N) (Salva Kumar N) (TH Samiulha)

- Environmental tests were carried out as per International Energy Agency Task 27 standards.
- RoHS, REACH, and VOC tests were carried out at TUV Rheinland, Bangalore.
- Sulphur dioxide-based corrosion test was carried out at TUV Rheinland, Germany.
- Accelerated weathering test was carried out at Ventest Solutions, Bangalore.
- Photothermal conversion efficiency measurement was carried out at Regional Testing Centre, Madurai Kamaraj University, Madurai.



A TÜVRheinland

Precisely Right.

#### **RoHS Certificate**

CSIR NAL Bangalore - 560017 NALSUN-NG PANEL

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Test Report - Industry Se	rvices		
Prüfbericht - Nr.: Test Report No.:	IND/BLR/CH/2022/1653		Seite 1 von 4 Page 1 of 4
ULR No:	TC56882250000001653F		
Auftraggeber: Client:	NATIONAL AEROSPACE LABORATORIES VIMANAPURA POST OFFICE, HAL AIRPORT Bangalore 560017.	ROAD,	
Kunden-referenz-Nr.: Client reference no.:	Email Dated: 2022.02.24	Auftrags-Nr: Order no.:	146655116
Gegenstand der Prüfung: Test item:	GOFP-5	Auftragsdatum: Order date.:	2022.02.24
Bezeichnung Typ-Nr.: Identification / Type No.:	-	Wareneingangs datum: Date of sample receipt:	2022.03.08
Auftrags-Inhalt: Order content:	Chemical Test	Prüfmuster-Nr: Test sample no.:	1653
	RoHS Directive Compliance :		
Prüfgrundlage: Test specification:	Restriction of the use of Hazardous Substances Directive 2011/65/EU, RoHS2 including Phthalates as per EU/2015/863.	Prüfzeitraum Testing Period:	2022.03.08 to 2022.03.28
Ort der Prüfung: Place of testing:	Plot No. 27B, 2 <sup>nd</sup> Cross, Electronic City Phase1 Karnataka, India.	, Hosur Road, Ban	galore - 560 100,
Prüflaboratorium: Testing laboratory:	TÜV Rheinland (India) Private Limited		
Prüfergebnis: Test Result:	PASS		

#### **REACH Certificate** A TÜVRheinland\*

Precisely Right.

Test Rep	ort – Industry Services	Precisely	Right.	
Prüfbe Test R ULR N	richt - Nr.: eport No.: IND/BLR/CH/2022/6751 o.: TC568822500006751P		Seite 23 von 23 Page 23 of 23	
SI.No.	Substance name	CAS No.	Results (%)	
222	S-(tricycle (5.2.1.02.6)deca-3-en-8(or 9)-yl O- (isopropylor isobutyl or 2-ethylhexyl) O-(isopropyl or isobutyl or 2-ethylhexyl) Phosphorodithioate	255881-94-8	ND	
223	Tris (2-methoxyethoxy)vinylsilane	1067-53-4	ND	
Note : ND denotes not detected, % denotes percentage         1. The substances are tested in term of its respective elements only (eg.As, Pb, cd). The actual concentration of its compound cannot be confirmed         2. The substances are tested in term of Cr(VI)         3. Single substances are tested in term of Cr(VI)         3. Single substances with an amount of <0.01% were not considered by the calculation of the sum.				

Test Item Photograph:



#### **Corrosion Resistance Test**

Prüfbericht - Nr.: Test Report No.:	IND/BLR/CH/2022/4515	Seite 1 Page	<b>von 4</b> 1 of 4		
Auftraggeber: Client:	NATIONAL AEROSPACE LABORATORIES Virnanapura Post Office, HAL Airport Road, Bangalore-560017, India.				
Kunden-referenz-Nr.: Client reference no.:	Email Dated: 2022.05.26	Auftrags-Nr: Order no.:	146683861		
Gegenstand der Prüfung: Test item:	Coated Panel	Auftragsdatum: Order date:	2022.07.08		
Bezeichnung Typ-Nr.: Identification / Type No.:	-	Wareneingangsdatum: Date of sample receipt:	2022.07.22		
Auftrags-Inhalt: Order content:	Sulfur Dioxide test	Prüfmuster-Nr: Test sample no.:	4515		
Prüfgrundlage: Test specification:	As per ISO 10062: 2006	Prüfzeitraum Testing Period:	2022.07.08 to 2022.07.22		
Ort der Prüfung: Place of testing:	Plot No. 27B, 2 <sup>nd</sup> Cross, Electronic City Phase1, Hosur Road, Bangalore-560100 Karnataka, India.				
Prüflaboratorium: Testing laboratory:	TÜV Rheinland (India) Private Limited				
Prüfergebnis: Test Result:	PASS, Refer Page No.2 to 4				



est Report – Industry Services			Precisely Right.			
Prüfbericht - Nr.: Test Report No.:	IND/BLR/CH/2022	2/7003	s	Seite 1 von 3 Page 1 of 3		
Auftraggeber: Client:	NATIONAL AEROS Vimanapura Post C Bangalore - 560017	ES d,				
Kunden-referenz-Nr.: Client reference no.:	E-mail date: 04.08.2022		Auftrags-Nr: Order no.:	146706097		
Gegenstand der Prüfung: Test item:	GOFP-23		Auftragsdatum: Order date.:	2022.08.04		
Bezeichnung Typ-Nr. Identification / Type No	: Oil Sample		Wareneingangsdatum: Date of sample receipt:	2022.08.04		
Auftrags-Inhalt: Order content:	Customer requirement : Volatile Organic Compound (VOC) test		Prüfmuster-Nr: Test sample no.:	7003		
Prüfgrundlage: Test specification:	VOC		Prüfzeitraum Testing Period:	2022.08.19 2022.08.26		
Ort der Prüfung: Place of testing:	Plot No. 27B, 2 <sup>nd</sup> Karnataka, India.	Cross, Electronic City I	Phase1, Hosur Road, Bang	alore - 560 1		
Prüflaboratorium: Testing laboratory:	TÜV Rheinland (Ind	dia) Private Limited				
Prüfergebnis: Test Result:	Refer Page No.2 to	3				
Zusammengestellt: compiled by	Anbukumar S	Genehmigt von: Aut	horized by: Rajesh Jain	в		
Datuvm:	2022-08-30	Ausstelldatum:	2022-08-30			
Stellung / Position:	Manager – Operation, Material Testing Laboratories	Stellung / Position:	Asst. Gener Material Tes Laboratories	al Manager iting		
Sonstiges/ Other: Nil.						
Zustand des prüfgeg Condition of the test ite	enstandes bei Anlief am at the time of delive	erung: Good. Accepta	ble for Test Requested.			
Abkürzungen: ok / P = fail / F = n.a. / N =	entspricht Prüfgrundlage entspricht nicht Prüfgrundl nicht anwendbar	Abbreviations: lage	ok / P = passed fail / F = failed n.a. / N = not applicable			
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For more information, please contact:



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