

SCS PARYFREE®

Halogen-Free Parylene Coating



SPECIALTY COATING SYSTEMS™

A KISCO Company

SCS

INNOVATIVE SOLUTIONS FROM THE LEADER IN PARYLENE

With over 45 years of experience in Parylene engineering and applications, Specialty Coating Systems (SCS) is the world leader in Parylene conformal coating technologies. We're a direct descendant of the companies that originally developed Parylene, and we leverage that expertise on every project – from initial planning to process application.

SCS employs some of the world's foremost Parylene specialists, highly experienced sales engineers and expert manufacturing personnel, working in state-of-the-art coating facilities in 11 countries worldwide. Our extensive, proactive approach to production and quality requirements gives our customers peace of mind and minimizes the resources they need to meet even the most challenging requirements and specifications.



HALOGEN-FREE ELECTRONICS

The rapid growth and adoption of consumer electronics around the world has resulted in an increased awareness of potential environmental issues related to their disposal. Halogens, which have had various uses in electronics over the years, are known to emit toxic and corrosive gases during the disposal of electronic waste.

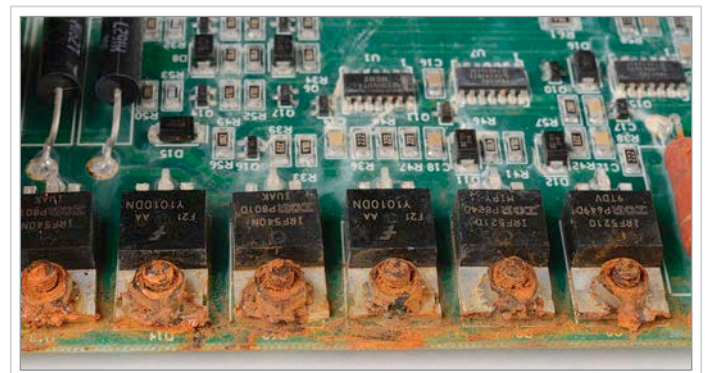
Non-government organizations (NGOs) first highlighted environmental concerns and, since, have applied pressure to the electronics industry to eliminate halogens (e.g., fluorine, chlorine, bromine and iodine) from their products. As a result, the International Electromechanical Commission (IEC) moved to define 'halogen-free' as ≤ 900 ppm for chlorine, ≤ 900 ppm for bromine and ≤ 1500 ppm total for both combined. Due to the pressure applied by NGOs and the guidance set forth by the IEC, many consumer electronic companies have committed to eliminating halogens from their products.

Specialty Coating Systems has a notable history of anticipating and responding to industry trends and regulations. In support of the global initiatives that continue to drive toward the elimination of halogens in electronics, SCS has developed a new halogen-free variant of Parylene – ParyFree®.

FIGURE 1: Circuit boards after 144 hours of salt-fog exposure



Coated with SCS ParyFree



Uncoated



Like other commercially-available Parylene variants, ParyFree is applied through a vapor deposition process that results in an ultra-thin, uniform, pinhole-free conformal coating. The thin film forms at a molecular level to fully encapsulate components and devices, offering complete protection and increased reliability of intricate, complex electronic devices. To verify its efficacy as a halogen-free material, ParyFree coatings were tested in accordance with BS EN 14582:2007 at an independent testing facility. The results, which are displayed in Table 1, show that there are no detectable levels of chlorine, bromine, fluorine or iodine in ParyFree coatings, validating the coating's use in halogen-free applications.

ParyFree coating offers manufacturers the same host of beneficial properties that they have come to expect from the Parylene family, but with improved barrier properties over traditional halogen-free variants. As a demonstration of their barrier properties, circuit boards coated with ParyFree were salt-fog tested by an independent facility. The coated boards exhibited no corrosion, salt or heavy iron oxide deposits after 144 hours of exposure in accordance with ASTM B117-(03) (see Figure 1). Boards coated with SCS Parylenes C and Parylene HT exhibited similar results. Table 2 shows key attributes of Parylene

TABLE 1: ParyFree® Halogen Testing

Per BS EN 14582:2007, detection limit of 50 ppm (mg/Kg)

Halogen	CAS	Halogen in ParyFree®
Chlorine (Cl)	7782-50-5	Not Detected
Bromine (Br)	7726-95-6	Not Detected
Fluorine (F)	7782-41-4	Not Detected
Iodine (I)	7553-56-2	Not Detected

conformal coatings and how they compare to other common coating materials.

ParyFree-coated electronics have also been tested in accordance with the applicable requirements of IEC 60529, test conditions 14.2.7 and 14.2.8 for IPX7 and IPX8 designations, which demonstrates protection from harmful effects due to the ingress of water. The uncoated (control) electronics functionally failed during the test, but all ParyFree-coated electronics passed both test conditions, functioning normally both during and after testing. These tests demonstrate that ParyFree conformal coating is suitable to protect electronics and other devices against water splash and water immersion for more than 30 minutes at a depth of 1 m (IPX7) and 1.5 m (IPX8).

SCS PARYLENE COATING SERVICES

SCS provides Parylene conformal coating services and technologies to customers throughout the electronics, aerospace, defense, transportation and medical device industries. As a family of protective coatings, the Parylenes provide many beneficial attributes, including:

- Excellent chemical and moisture barrier properties
- Excellent dielectric properties
- Ultra-thin, conformal coating of all exposed surfaces
- Excellent crevice and multi-layer penetration
- Thermal stability up to 450°C (short-term)
- Unparalleled ultraviolet stability
- Biocompatibility and biostability

As worldwide industry requirements and directives continue to evolve, SCS is at the forefront, ensuring our products and services comply with relevant regulatory, environmental and biological standards.

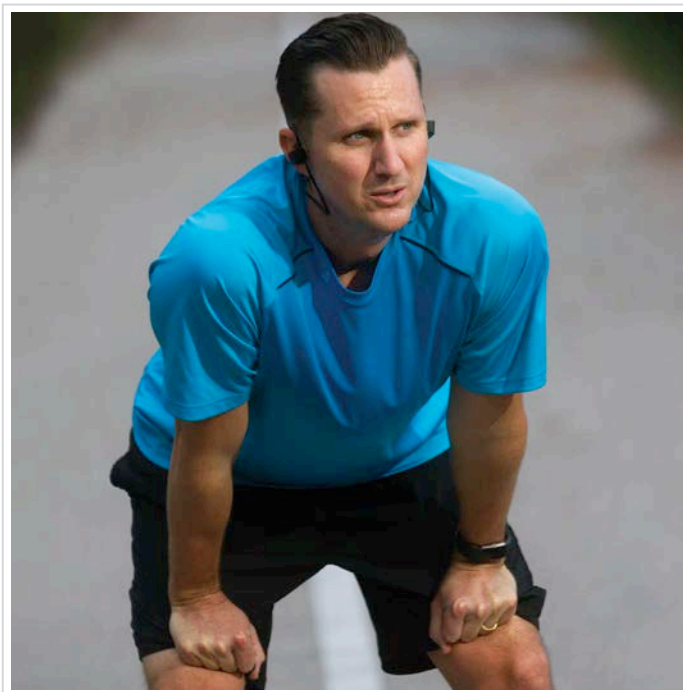


TABLE 2: Parylene Properties

		Method	Parylene N	ParyFree	Parylene C	Parylene HT	Acrylic (AR) ^{a,b}	Epoxy (ER) ^{a,b}	Polyurethane (UR) ^{a,b}	Silicone (SR) ^{a,b}
Dielectric Strength V/mil		1	7,000	6,900	5,600	5,400	3,500	2,200	3,500	2,000
Dielectric Constant	60 Hz	2	2.65	2.38	3.15	2.21	–	3.3 – 4.6	4.1	3.1 – 4.2
	1 KHz		2.65	2.37	3.10	2.20	–	–	–	–
	1 MHz		2.65	2.35	2.95	2.17	2.7 – 3.2	3.1 – 4.2	3.8 – 4.4	3.1 – 4.0
Dissipation Factor	60 Hz	2	0.0002	0.00001	0.020	<0.0002	0.04 – 0.06	0.008 – 0.011	0.038 – 0.039	0.011 – 0.02
	1 KHz		0.0002	0.0009	0.019	0.0020	–	–	–	–
	1 MHz		0.0006	0.0007	0.013	0.0010	0.02 – 0.03	0.004 – 0.006	0.068 – 0.074	0.003 – 0.006
Water Vapor Transmission Rate (g•mm)/(m ² •day)		3, 4, 5, 6	0.59	0.09	0.08	0.22	13.9 ^c	0.94 ^c	0.93 – 3.4 ^c	1.7 – 47.5 ^c
Water Absorption (% after 24 hours)		7	<0.1	<0.1	<0.1	<0.01	0.3	0.05 – 0.10	0.6 – 0.8	0.1
Service Temperature	Continuous Short-Term	8	60°C 80°C	60°C 80°C	80°C 100°C	350°C 450°C	82°C –	177°C –	121°C –	260°C –
UV Stability		9	≤100 hrs	≤100 hrs	≤100 hrs	≥2,000 hrs	–	–	–	–
Coefficient of Friction	Static	10	0.25	0.23	0.29	0.15	–	–	–	–
	Dynamic		0.25	0.23	0.29	0.13	–	–	–	–
Tensile Strength (psi)		11	7,000	9,600	10,000	7,500	7,000 – 11,000	4,000 – 13,000	175 – 10,000	350 – 1,000
Penetration Ability ^d			40 x dia.	10 x dia.	5 x dia.	50 x dia.	Spray or Brush	Spray or Brush	Spray or Brush	Spray or Brush
Rockwell Hardness		12	R85	R136	R80	R122	M68 – M105	M80 – M110	68A – 80D (Shore)	40A – 45A (Shore)
USP Class VI Polymer			Yes	Not Yet Available	Yes	Yes	Varies	Varies	Varies	Varies
Biocompatibility ^e			ISO 10993	Not Yet Available	ISO 10993	ISO 10993	Varies	Varies	Varies	Varies

a. *Handbook of Plastics, Elastomers, and Composites*, Chapter 6, “Plastics in Coatings and Finishes,” 4th Edition, McGraw Hill, Inc., New York, 2002.

b. *Conformal Coating Handbook*, Humiseal Division, Chase Corporation, Pennsylvania, 2004.

c. *Coating Materials for Electronic Applications*, Licari, J.J., Noyes Publications, New Jersey, 2003.

d. Depth into tubing and crevices.

e. Contact SCS Marketing for specific results.

Test Methods:

1. ASTM D149

2. ASTM D150

3. ASTM E96 (at 90% RH, 37°C) (Parylene N only)

4. ASTM F1249 (at 100% RH, 37°C) (ParyFree only)

5. ASTM F1249 (at 90% RH, 37°C) (Parylene C only)

6. ASTM F1249 (at 100% RH, 38°C) (Parylene HT only)

7. ASTM D570

8. TGA/FTIR, DSC and thermal endurance testing

9. ASTM G154

10. ASTM D1894

11. ASTM D882

12. ASTM D785



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