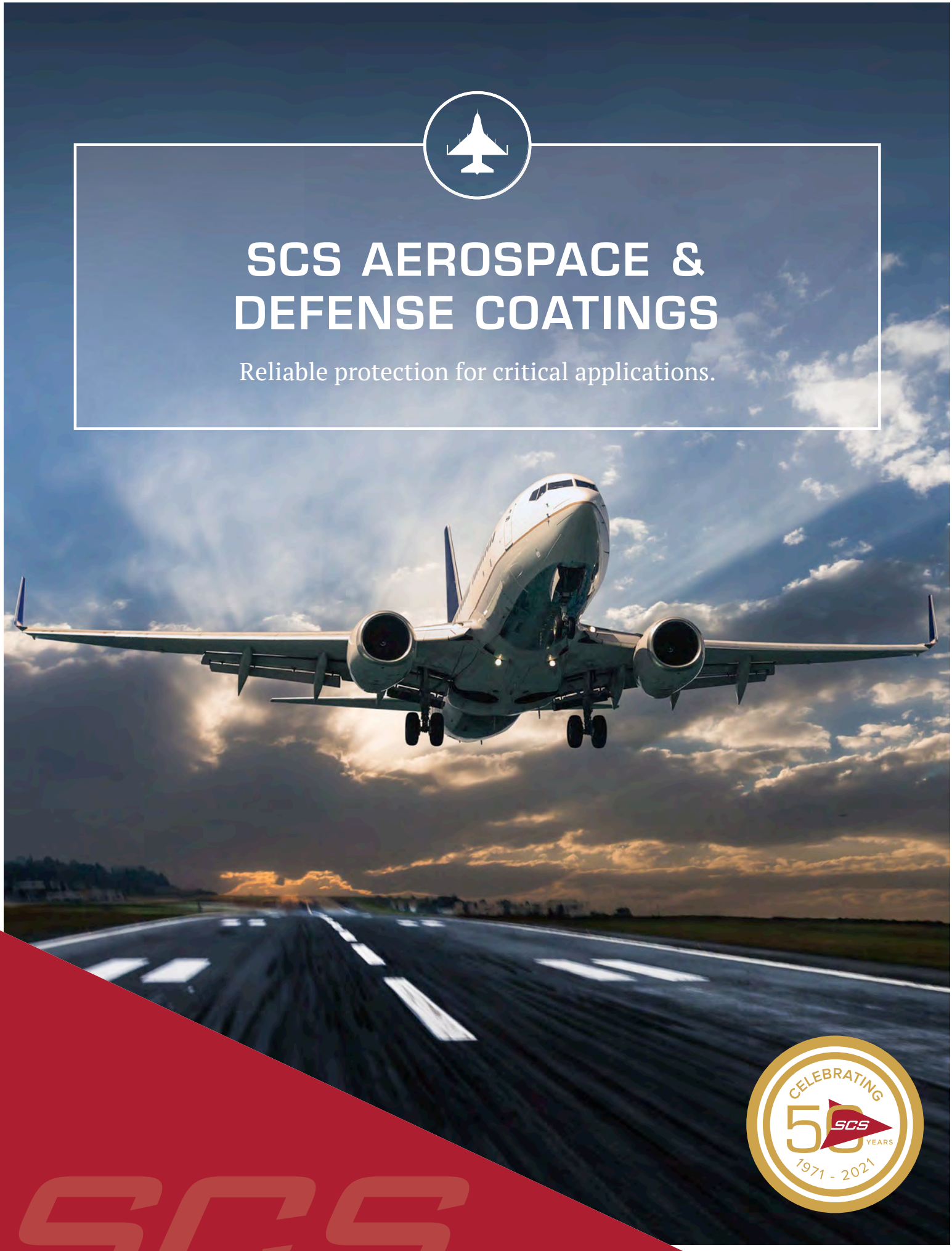
SCS AEROSPACE & DEFENSE COATINGS

Reliable protection for critical applications.



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.

50 years

11 countries

3 continents

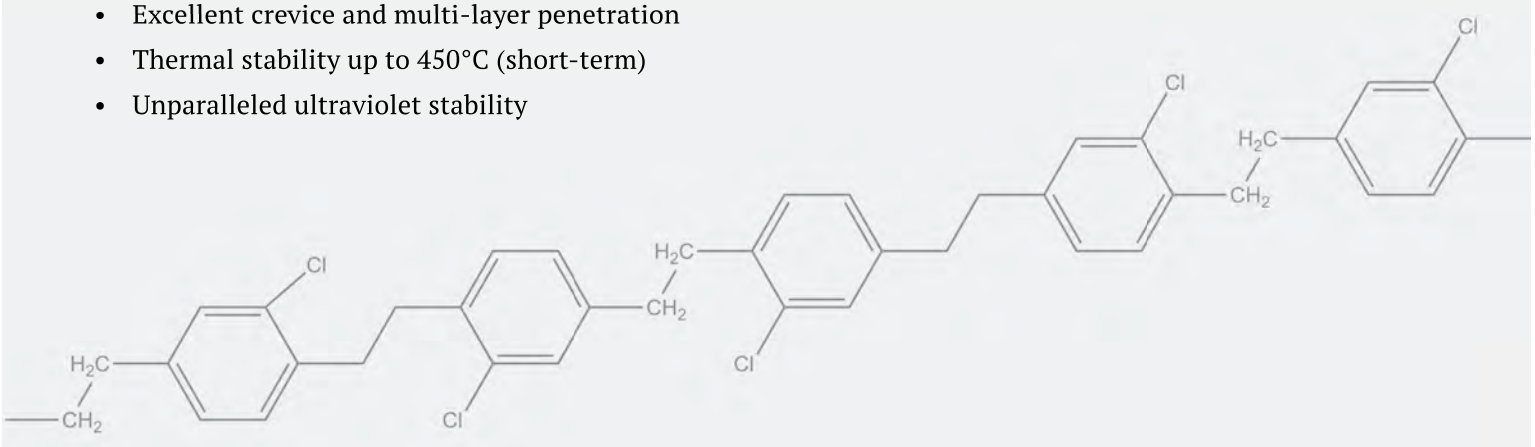
>1,000 employees

SCS PARYLENE COATINGS

SCS combines the properties of Parylene with its years of experience, vast technologies and worldwide resources to provide the aerospace and defense industries with reliable coatings and services, including Parylene HT®, which is specifically engineered to withstand the most extreme conditions in the industry.

Ultra-thin and pinhole-free, SCS Parylene coatings offer beneficial attributes, including:

- Excellent dielectric properties
- Excellent chemical and moisture barrier 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



PROPERTIES OF SCS PARYLENE COATINGS

BARRIER PROPERTIES

SCS Parylene coatings are excellent moisture and chemical barriers. Applied in the micron range, much thinner than industry standard coatings, Parylene provides a superior pinhole-free, uniform barrier to protect against corrosive liquids, fluids, gases and chemicals, even at elevated temperatures.

Circuit boards coated with Parylene HT were salt-fog tested by an independent testing facility. The coated boards showed no corrosion or salt deposits after 144 hours of exposure in accordance to ASTM B117-(03) (See Figure 1). Boards coated with SCS Parylenes C and ParyFree®, a new halogen-free variant of Parylene, exhibited similar results.

CHEMICAL RESISTANCE

The Parylenes resist chemical attack and are insoluble in all organic solvents up to 150°C. Parylene films show no changes to the coating's physical and chemical properties after exposure to a host of acids and bases, including harsh aerospace fluids.

DIELECTRIC PROPERTIES

SCS Parylenes have excellent dielectric properties. Their high dielectric strength is attributable to the fact that they can be formed as thin, continuous films, free from the defects and fillers commonly found in conventional coatings that tend to reduce dielectric strength.

SCS Parylenes have low dielectric constants and dissipation factors and high dielectric strengths, enabling electrical signal transfer without absorption or loss.

THERMAL

Many components in the aerospace and defense industries require protection in the midst of extreme environments. Based on Arrhenius extrapolations of test data, Parylenes N, ParyFree and Parylene C are expected to survive continuous exposure to air at 60°C, 60°C and 80°C, respectively, for 10 years. In oxygen-free atmospheres, or in the vacuum of space, the Parylenes are expected to perform similarly with continuous exposure to 220°C. SCS Parylene HT has been demonstrated to survive continuous exposure to air at 350°C, with excursions to 450°C for less than 24 hours, offering excellent protection to many aerospace and defense applications.

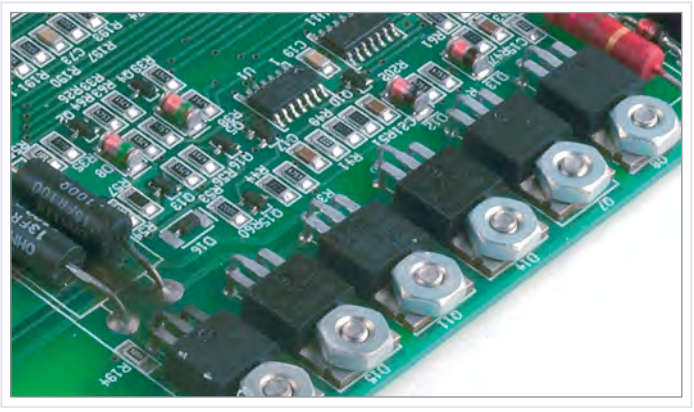
CRYOGENIC

Unsupported 50.8 µm films of Parylene C can be flexed 180° six times at -200°C before failure occurs. Comparable films of polyethylene, polyethylene terephthalate and polytetrafluoroethylene fail at three, two and one flexes, respectively.

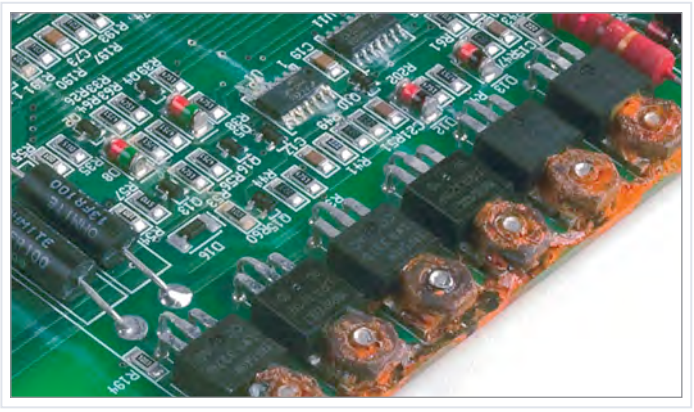
Steel panels coated with Parylene C and chilled in liquid nitrogen at -196°C withstood impacts of more than 11.3 N•m in a modified Gardner falling ball impact test. This compares with values of about 28.2 N•m at room temperature.

Supported films of Parylene N have been demonstrated to withstand thermal cycling from room temperature to -269°C without cracking, peeling from substrate or the degradation of electrical properties.

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



Coated with SCS Parylene HT



Uncoated

SCS 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** **1 KHz** **1 MHz**	2	2.65 2.65 2.65	2.38 2.37 2.35	3.15 3.10 2.95	2.21 2.20 2.17	– – 2.7 – 3.2	3.3 – 4.6 – 3.1 – 4.2	4.1 – 3.8 – 4.4	3.1 – 4.2 – 3.1 – 4.0
Dissipation Factor	**60 Hz** **1 KHz** **1 MHz**	2	0.0002 0.0002 0.0006	0.00001 0.0009 0.0007	0.020 0.019 0.013	<0.0002 0.0020 0.0010	0.04 – 0.06 – 0.02 – 0.03	0.008 – 0.011 – 0.004 – 0.006	0.038 – 0.039 – 0.068 – 0.074	0.011 – 0.02 – 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 (Accelerated weathering test)		9	≤100 hrs	≤100 hrs	≤100 hrs	≥2,000 hrs	–	–	–	–
Tensile Strength (psi)		10	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

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.

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 D882

UV STABILITY

SCS Parylene HT offers measurable UV stability after a 2,000 hour accelerated UV exposure test (ASTM G154). Its chemical structure provides protection from degradation and discoloration as a result of such exposure.

VACUUM STABILITY

Testing conducted at NASA's Jet Propulsion Laboratory (at 49.4°C and 10^{-6} torr) indicates Total Mass Loss (TML) of 0.30% for Parylene N. NASA's Goddard Space Flight Center's vacuum stability testing (per ASTM E595) of SCS Parylene C and Parylene HT demonstrates TML of 0.07% and 0.03%, respectively. Corresponding values for Collected Volatile Condensable Materials (CVCM) are 0.0003% and 0.0017%, respectively. For more information on outgassing, please visit http://outgassing.nasa.gov or contact SCS.

METAL WHISKER MITIGATION

As a result of industry directives, pure metal plating is replacing lead in the solders used throughout the worldwide electronics industry. While safer for the environment, metal plating is known to form whiskers, which cause reliability problems for electronic systems. Parylene coatings suppress the formation of metallic whiskers, OSEs (odd shape eruptions) and dendrites.

RADIATION RESISTANCE

Parylenes N, C, D and Parylene HT films show a high degree of resistance to degradation by gamma rays in vacuum. Tensile and electrical properties were unchanged after 1,000 kGy dosage at a dose rate of 16 kGy/hr. Exposure in air leads to rapid embrittlement.

OPTICAL PROPERTIES

Parylenes exhibit very little absorption in the visible region and are, therefore, transparent and colorless. Below wavelengths of about 280 nm, all the Parylene variants demonstrate high levels of absorption.

PARYLENE C-UVF®

Because Parylene coatings are optically clear, there is an inherent level of difficulty involved in identifying whether a component has been coated. As a solution to this challenge, SCS developed a unique technology to assist customers in the process of identifying Parylene-coated boards — SCS Parylene C-UVF®. Parylene C-UVF maintains the same electrical, mechanical and physical properties of Parylene C but also fluoresces under black light.

PROTECTION FOR ADVANCED APPLICATIONS

SCS can apply Parylene coatings to virtually any surface material, including metals, elastomers, resins, plastics and ceramics, in thicknesses ranging from a few hundred angstroms to several mils. Parylenes polymerize as uniform, thin-film coatings that conform to all surfaces, edges and crevices of a substrate, including the interior of multi-layer electronic packages. As a result of their ultra-thin application, Parylenes add little dimension or mass to critical, weight-sensitive components.

SCS employs the unique properties of the Parylenes to provide specialized conformal coating solutions to customers in the following industries:

AEROSPACE

Manufacturers are continually seeking ways to reduce weight in order to increase operating efficiencies. Parylene coatings, which are typically applied in micron-level thickness, are ultra-thin and lightweight. They provide aerospace components with excellent barrier properties, including pinhole-free protection from corrosive liquids, fluids, gases and chemicals, even at elevated temperatures. Parylenes are ideal coatings for circuit boards, sensors and other components used to monitor electrical, air handling, fuel and engine systems, and flight control systems.

SCS Parylene HT offers excellent UV stability, providing a reliable solution for interior and exterior LED applications. In addition, the Parylenes do not contain any fillers, so there is very little light reduction.

DEFENSE

As the defense industry continues to integrate COTS (commercial off-the-shelf) components, which were not specifically designed for demanding environments, into their systems, Parylene coatings provide necessary protection to increase the life of these components. Parylenes offer outstanding barrier and complete encapsulation properties that provide reliable protection for critical applications.

The UAV (unmanned aerial vehicle) segment continues to expand into new categories such as micro, autonomous land and underwater vehicles. Parylenes are ideal conformal coatings in these applications due to their ultra-thin and lightweight nature. Additionally, Parylenes are optically clear and do not interfere with electrical, optical or RF signals.

When space is a premium and weight is a determining factor, Parylene coatings provide unmatched protection for critical defense systems.

SPACE

Parylenes have a long history of protecting components used in satellites, space-borne instrumentation and vehicles. Since the coatings are applied in a vacuum, there are no hidden voids or incomplete coverage that, when exposed to altitude, may present pathways for failure. Parylenes also offer excellent dielectric properties for space applications, even at elevated frequencies.

ENVIRONMENT-FRIENDLY COATINGS AND PROCESSES

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

- SCS maintains AS9100 and ISO 9001 certified coating centers.
- SCS Parylenes meet the requirements of IPC-CC-830.
- SCS Parylenes are listed in the QPL for MIL-I-46058C.
- SCS Parylenes C and HT are UL (QMJU2) recognized.
- SCS Parylenes are listed in the International Aerospace Database (OASIS).
- SCS Parylenes are REACH and RoHS compliant.

For additional standards and certifications to which SCS and/or SCS Parylene coatings comply, please visit SCScomplies.com or contact SCS.

THE PARYLENE PROCESS

SCS Parylene coatings are applied in a room temperature vacuum chamber via a vapor deposition polymerization (VDP) process. Components to be coated are only required to have a reasonable vacuum tolerance. There are no solvents, catalysts or plasticizers involved in the coating process; since Parylene coatings require no elevated temperature cure cycle, there are no associated cure stresses. Unlike Parylene coatings, conventional dipped, sprayed or brushed coatings may require catalysts, cross-linking, elevated temperatures or UV cure cycles to improve coating properties.

Room Temperature | Molecular-level Deposition | No Solvents, Catalysts or Plasticizers

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