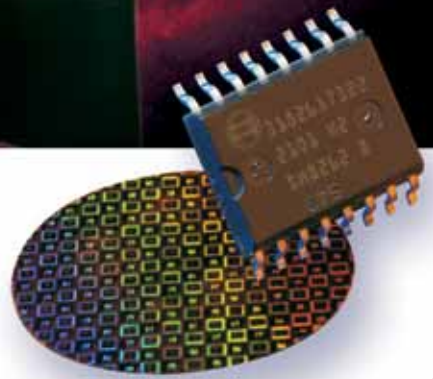




SPECIALTY COATING SYSTEMS™



Advanced protection for extreme environments.



SCS AUTOMOTIVE COATINGS

Specialty Coating Systems is the global leader in delivering Parylene conformal coating solutions for advanced technologies. For more than three decades, customers have turned to SCS for the planning, development, engineering and applying of thin-film Parylene polymer coatings to their critical components.

A team of the world's foremost Parylene specialists, strict quality control systems, and state-of-the-art coating facilities across the Americas, Asia and Europe ensure SCS customers receive the most innovative, precise and consistent coating processes . . . for components and applications where compromise is not an option.

SCS provides innovative solutions for advanced technologies, including Parylene coatings that protect critical components in harsh automotive environments. Parylene coatings provide benefits that enable smaller, more reliable, longer-lasting electronic packages and components, as demanded by the competitive automotive market.

SCS Parylene Coatings

Ultra-thin and pinhole-free, SCS Parylene coatings offer exceptional properties for automotive component protection. SCS combines the properties of Parylene with its years of experience, vast technology and worldwide resources to provide the automotive industry with Parylene coatings and services it can rely on, including Parylene HT®, specifically engineered to withstand the most extreme conditions.

The benefits of SCS Parylene HT include:

- Thermal stability in harsh environments, up to 450°C
- Superior fluid, chemical, moisture and electrical barrier
- Excellent crevice and multi-layer penetration
- Unparalleled ultraviolet stability
- Ultra-thin, conformal coating of all exposed surfaces

Environment-Friendly Coatings and Processes

RoHS Compliance

Independent testing has certified that SCS Parylene coating services and dimer are in compliance with the European Union's Restriction on the use of Hazardous Substances (RoHS) in Electrical and Electronic Equipment Directive 2002/95/EC. Similar regulations exist in other countries as well.

Tin Whisker Mitigation

As a result of the RoHS directive, pure tin plating is replacing lead in the tin-alloy solder used in the worldwide electronics industry. While safer for the

environment, tin plating is known to form tin whiskers, which cause reliability problems for electronic systems. SCS Parylene coatings suppress the formation of metallic whiskers, OSEs (odd shape eruptions) and dendrites.

Parylene Coating Properties that Protect Barrier Properties

SCS Parylene coatings are excellent moisture and chemical barriers for automotive components. 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, gasses and chemicals, even at elevated temperatures. Table 1 shows that Parylene HT films did not swell significantly with exposure to automotive chemicals and fluids. Additionally, there were no perceivable changes in the film's visual or mechanical properties.

Circuit boards coated with SCS Parylene HT were salt-fog tested by an independent testing facility. The coated boards suffered no corrosion, salt or heavy iron oxide deposits after 144 hours of exposure in accordance with ASTM B117-(03) (See Figure 1). To discuss specific test results, contact SCS.

Thermal Stability

Harsh automotive operating environments range from -40°C to more than 300°C, making coating stability critical to the trouble-free life of vehicle electronics. SCS Parylene HT is specifically engineered to provide long-term thermal stability up to 350°C, with intermittent exposures up to 450°C.

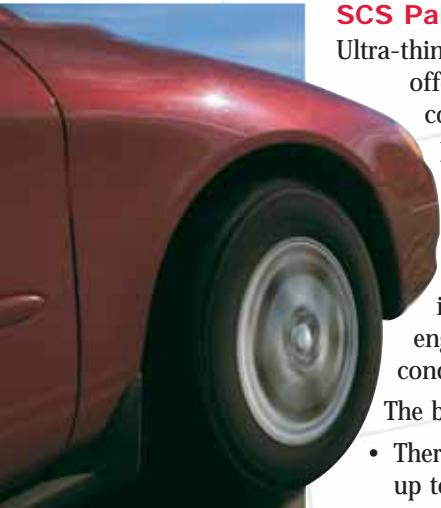
Figure 1: Circuit boards after 144 hours of salt-fog exposure



Coated with SCS Parylene HT



Uncoated



UV Stability

SCS Parylene HT is the only Parylene variant commercially available to offer measurable UV stability after more than 2,000 hours of UV exposure (ASTM G154). Its chemical structure provides protection from degradation and discoloration as a result of such exposure.

Dielectric Properties

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

SCS Parylene HT has the lowest dielectric constant and dissipation factor among industry standard coatings, enabling it to transfer electrical signals without absorption or loss.

Useful in Many Automotive Applications

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

Sensors

Today's engines and automotive systems rely on complex sensors to monitor the accuracy and operation of moving parts, fluid levels and pressures. Parylene's excellent barrier properties protect critical sensors from harsh chemicals, fluids and gasses, as well as high temperatures.

Hybrid and Fuel Cell Electronic Systems

Many major automotive companies have developed hybrid vehicles that utilize and generate electricity to reduce the world's reliance on oil for fuel. Parylene HT offers some of the best dielectric properties of protective coatings on the market – ensuring that the high level of power required for operating these hybrid electronic systems will not be weakened or distorted.

Fuel cells operate in the midst of corrosive compounds at elevated temperatures, a very harsh environment for electronics. Parylene HT is chemically structured to provide superior protection for these components.

MEMS

MicroElectroMechanicalSystems (MEMS) represent the cutting edge of automotive innovation and can hold anywhere from 1,000 to 10,000 devices on a

6-inch wafer. Parylene is an ideal protective coating since it is applied as a vapor and has excellent penetrating ability regardless of shape, size or complexity of the component.

Circuit Boards

SCS Parylene's conformal and uniform nature ensures complete coverage of circuit boards to protect against corrosion and contaminants with no meniscus, flowing or edge-effect flaws. The lightweight coating adds very little mass to even the smallest of circuit boards, which can be used in engine management systems, chip packaging and turbochargers.

Table 1

Automotive Chemical and Fluid Resistance of SCS Parylene HT

Chemical	Parylene HT Film Swelling
Automotive Fluids heated to 90°C	
Antifreeze — 50% solution	< 2.5%
Engine Oil — 10W30	
Transmission Fluid — Dexron III Mercon	
Automotive Chemicals heated to 75°C	
Nitric Acid — 10% and 70% solutions	< 1%
Sulfuric Acid — 10% solution	
Sulfuric Acid — 95%–98% solution	
Automotive Fluids at room temperature	
Brake Fluid — DOT 3	< 1.5%
Power Steering Fluid	
Windshield Washer Fluid	
Unleaded Gasoline — 87 Octane	
Diesel Fuel	

Testing Parameters:

Film thickness: 16–20 micron

Exposure time: 120 minutes

SCS Parylene Services

SCS Parylene coatings are applied in a 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 and since Parylene deposition occurs at ambient temperatures, there are no associated cure stresses. Unlike Parylene coatings, other industry coatings may require catalysts, elevated temperatures or cure cycles to improve coating properties.

With advances in SCS' worldwide resources and technologies, Parylene coatings are cost-competitive and, in many cases, less expensive than traditional coatings. In addition to a proven track record of timely processing and delivery of customer parts, SCS has years of experience with automotive quality standards, including ISO 9001:2000 certifications and PPAP processes.

Table 1		Method	Parylene HT	Parylene C	Parylene N	Acrylic (AR) ^{a,b}	Epoxy (ER) ^{a,b}	Polyurethane (UR) ^{a,b}	Silicone (SR) ^{a,b}
Water Vapor Transmission Rate (g•mm)/(m ² •day)		1, 2, 3	0.22	0.08	0.59	13.9 ^c	0.94 ^c	0.93 – 3.4 ^c	1.7 – 47.5 ^c
Water Absorption (% after 24 hours)		4	<0.01	<0.1	<0.1	0.3	0.05 – 0.10	0.6 – 0.8	0.1
Gas Permeability @ 25°C	N ₂	5	4.8	0.4	3.0	–	–	31.5	–
	O ₂	5	23.5	2.8	15.4	–	–	78.7	19,685
	CO ₂	5	95.4	3.0	84.3	–	–	1,181	118,110
Dielectric Strength V/mil		6	5,400	5,600	7,000	3,500	2,200	3,500	2,000
Dielectric Constant	60 Hz	7	2.21	3.15	2.65	–	3.3 – 4.6	4.1	3.1 – 4.2
	1 KHz		2.20	3.10	2.65	–	–	–	–
	1 MHz		2.17	2.95	2.65	2.7 – 3.2	3.1 – 4.2	3.8 – 4.4	3.1 – 4.0
Dissipation Factor	60 Hz	7	<0.0002	0.020	0.0002	0.04 – 0.06	0.008 – 0.011	0.038 – 0.039	0.011– 0.02
	1 KHz		0.0020	0.019	0.0002	–	–	–	–
	1 MHz		0.0010	0.013	0.0006	0.02 – 0.03	0.004 – 0.006	0.068 – 0.074	0.003 – 0.006
Service Temperature	Continuous		350°C	80°C	60°C	82°C	177°C	121°C	260°C
	Short-Term		450°C	100°C	80°C	–	–	–	–
UV Stability		8	≥2,000 hrs	≤100 hrs	≤100 hrs	–	–	–	–
Coefficient of Friction	Static	9	0.15	0.29	0.25	–	–	–	–
	Dynamic		0.13	0.29	0.25	–	–	–	–
Tensile Strength (psi)		10	7,500	10,000	7,000	7,000 – 11,000	4,000 – 13,000	175 – 10,000	350 – 1,000
Penetration Ability ^d			50 x dia.	5 x dia.	40 x dia.	Spray or Brush	Spray or Brush	Spray or Brush	Spray or Brush
Rockwell Hardness		11	R122	R80	R85	M68 – M105	M80 – M110	68A – 80D (Shore)	40A – 45A (Shore)

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 F 1249 (at 100% RH, 38°C) (Parylene HT only)
2. ASTM F 1249 (at 90% RH, 37°C) (Parylene C only)
3. ASTM E 96 (at 90% RH, 37°C) (Parylene N only)
4. ASTM D 570
5. ASTM D 1434

6. ASTM D 149
7. ASTM D 150
8. ASTM G 154
9. ASTM D 1894
10. ASTM D 882
11. ASTM D 785

Innovative solutions for advanced technologies.

Specialty Coating Systems leads the industry in providing Parylene solutions for our global customers' advanced technologies. SCS is a direct descendant of the companies that originally developed Parylene, and we have more than 35 years of experience and expertise that we leverage on every project for our customers – from the initial planning phases, to advanced engineering, to the development of application processes.

Our worldwide resources include highly experienced sales engineers, some of the world's foremost Parylene specialists, and expert manufacturing personnel, working in nine state-of-the-art coating facilities around the globe. In addition to Parylene services, we design and manufacture industry-leading Parylene deposition systems; liquid spray, dip and spin coating systems; ionic contamination test systems; and UV and thermal cure units. Our equipment is used in environments that range from university and research labs to high-volume production applications.

Our extensive and proactive approach to production and quality requirements – testing, validating, documenting and processing – provides our customers peace of mind and minimizes their resources needed to meet the most challenging industry specifications and quality requirements.

RoHS
COMPLIANT


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