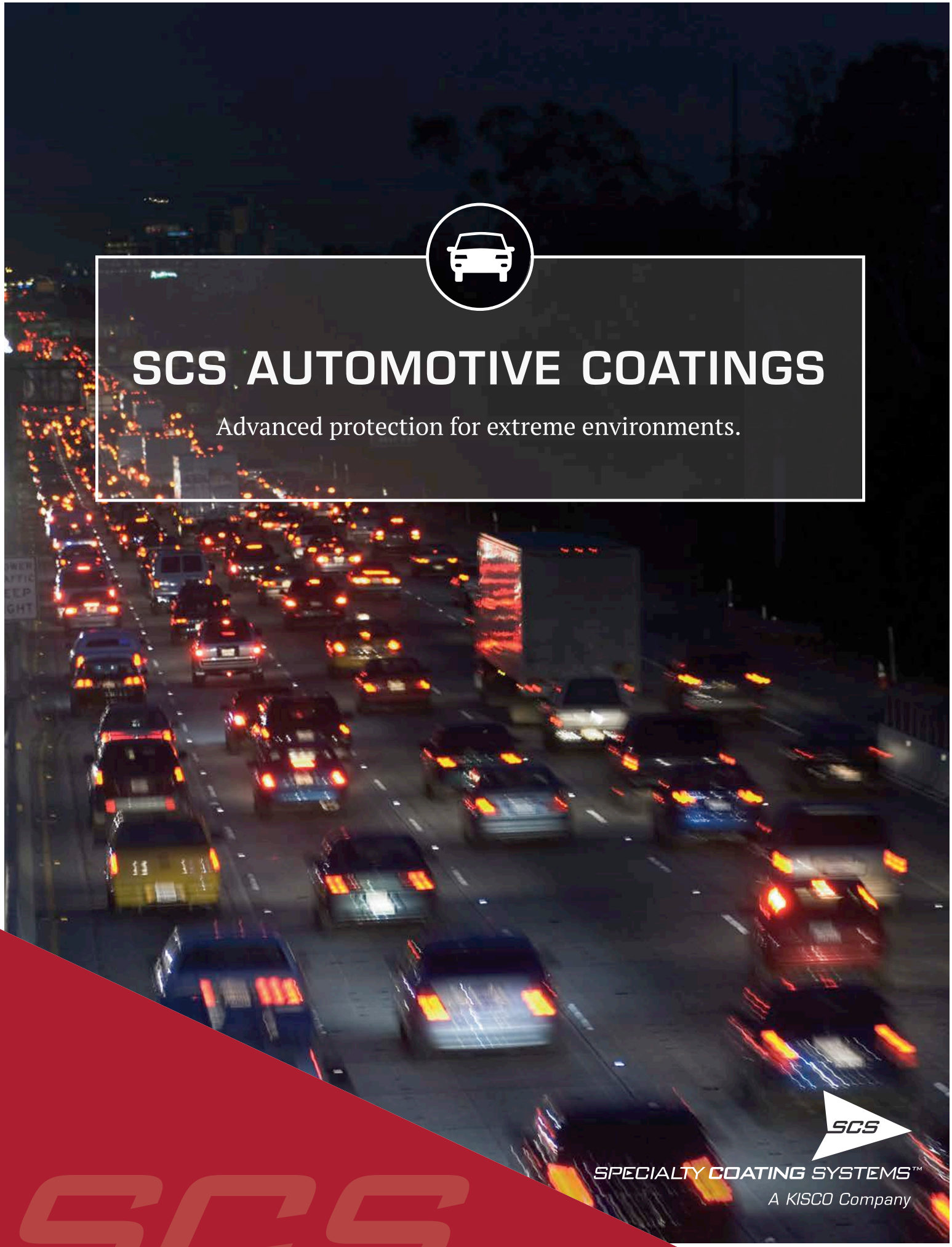


SCS AUTOMOTIVE COATINGS

Advanced protection for extreme environments.

SCS

SPECIALTY COATING SYSTEMS™

A KISCO Company

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 12 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.

>45 years

12 countries

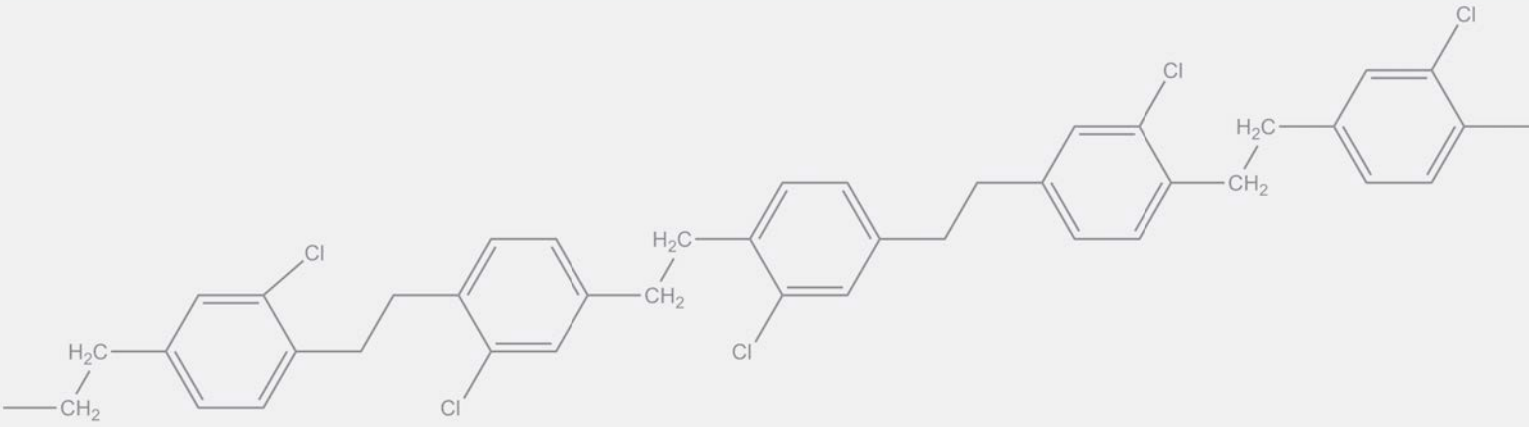
4 continents

>500 employees

SCS PARYLENE COATINGS

SCS combines the properties of Parylene with its years of experience, vast technology and worldwide resources to provide the automotive industry 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 exceptional properties, including:

- Thermal stability up to 450°C (short-term)
- Superior fluid, chemical, moisture and electrical barrier properties
- Excellent crevice and multi-layer penetration
- Unparalleled ultraviolet stability



ENVIRONMENT-FRIENDLY COATINGS AND PROCESSES

SCS COMPLIES

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.

SCS coating centers maintain AS9100C and ISO 9001:2008 certifications. Additionally, SCS Parylenes comply with the European Union's RoHS (Restriction of Hazardous Substances) Directive. SCS also has lead-free, halogen-free and low VOC initiatives to support our customers. For more information about SCS certifications and standards, visit SCScomplies.com.

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.

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, gases 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). Boards coated with SCS Parylene C exhibited similar results.

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 short-term stability up to 450°C.

UV STABILITY

SCS Parylene HT offers 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 the defects and fillers commonly found in conventional coatings that tend to reduce dielectric strength.

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

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 Engine Oil — 10W30 Transmission Fluid — Dexron Ill Mercon	<2.5%
Automotive Chemicals Heated to 75°C Nitric Acid — 10% and 70% solutions Sulfuric Acid — 10% solution Sulfuric Acid — 95% – 98% solution	<1%
Automotive Fluids at Room Temperature Brake Fluid — DOT 3 Power Steering Fluid Windshield Washer Fluid Unleaded Gasoline — 87 Octane Diesel Fuel	<1.5%

Testing Parameters:
Film thickness: 16-20 micron
Exposure time: 120 minutes

SCS PARYLENE PROPERTIES

		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 ($g \cdot mm/(m^2 \cdot day)$)		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 $\frac{cc \cdot mm}{m^2 \cdot day \cdot atm}$	N_2 O_2 CO_2	5	4.8 23.5 95.4	0.4 2.8 3.0	3.0 15.4 84.3	– – –	– – –	31.5 78.7 1,181	– 19,685 118,110
Dielectric Strength V/mil		6	5,400	5,600	7,000	3,500	2,200	3,500	2,000
Dielectric Constant	**60 Hz** **1 KHz** **1 MHz**	7	2.21 2.20 2.17	3.15 3.10 2.95	2.65 2.65 2.65	– – 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**	7	<0.0002 0.0020 0.0010	0.020 0.019 0.013	0.0002 0.0002 0.0006	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
Service Temperature	**Continuous** **Short-Term**		350°C 450°C	80°C 100°C	60°C 80°C	82°C –	177°C –	121°C –	260°C –
UV Stability		8	≥2,000 hrs	≤100 hrs	≤100 hrs	–	–	–	–
Coefficient of Friction	**Static** **Dynamic**	9	0.15 0.13	0.29 0.29	0.25 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 F1249 (at 100% RH, 38°C) (Parylene HT only)
2. ASTM F1249 (at 90% RH, 37°C) (Parylene C only)
3. ASTM E96 (at 90% RH, 37°C) (Parylene N only)
4. ASTM D570
5. ASTM D1434
6. ASTM D149
7. ASTM D150
8. ASTM G154
9. ASTM D1894
10. ASTM D882
11. ASTM D785

USEFUL IN MANY AUTOMOTIVE APPLICATIONS

SCS can apply Parylene coatings to virtually any surface material, including metals, resins, elastomers, plastics and ceramics, 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 gases, even in high temperature environments.

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.

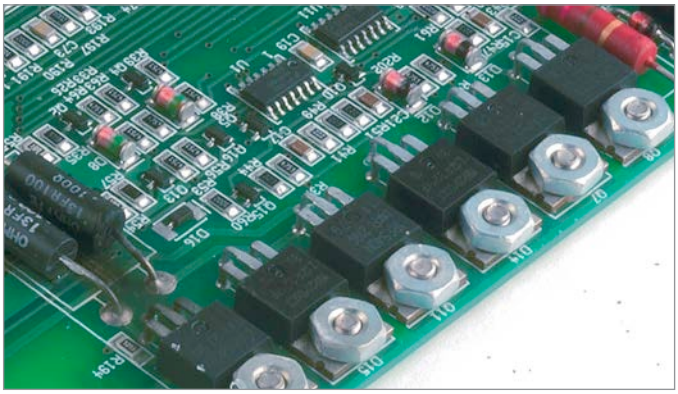
MEMS

MicroElectroMechanicalSystems (MEMS) continue to represent the cutting-edge of automotive innovation, often replacing previous generation single-sensors. Today's multi-capacity MEMS packages can be found controlling many critical automotive systems, including engine management, safety and security, tire pressure monitoring (TPMS), electronic stability, oil pressure, fuel injection, and pedestrian protection. Since Parylene is deposited as a gas, it is an ideal coating to protect complex MEMS wafers.

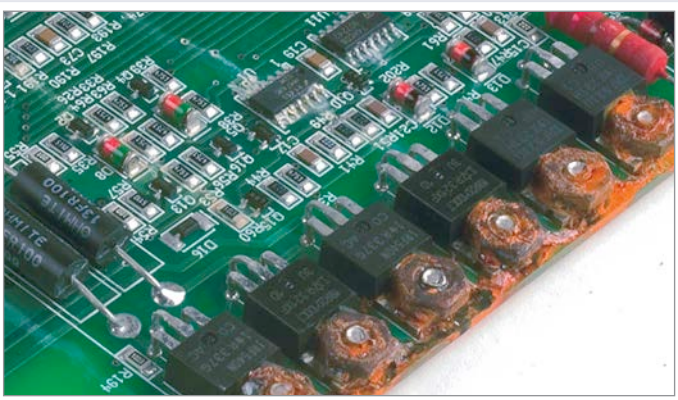
CIRCUIT BOARDS

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-effects. The lightweight coating adds very little mass to even the smallest of circuit boards used in engine management systems, chip packaging and turbochargers.

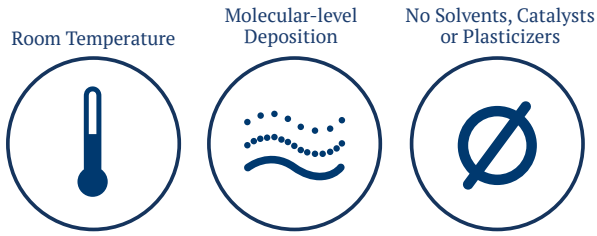
FIGURE 1: Circuit boards after 144 hours of salt-fog exposure



Coated with SCS Parylene HT



Uncoated



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 and, 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.

SCS
SPECIALTY COATING SYSTEMS™
A KISCO Company

7645 Woodland Drive, Indianapolis, IN 46278 United States
TF 800.356.8260 | **P** 317.244.1200 | **W** scscoatings.com