



SCS AUTOMOTIVE COATINGS

Advanced protection for extreme environments.



SCS CONFORMAL COATINGS

SCS' industry-leading portfolio of conformal coatings includes Parylene coatings, liquid coatings, plasma polymerized coatings, atomic layer deposition (ALD) coatings and multilayer coatings. Combining the properties of these coatings with over 50 years of experience, vast technology and worldwide resources, SCS provides the automotive industry with reliable coatings and services, including products like Parylene HT®, which is specifically engineered to withstand the most extreme

conditions in the industry. SCS conformal coatings offer beneficial attributes, including:

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

CONFORMAL COATING PROPERTIES THAT PROTECT

Following is an overview of the most common properties and benefits of SCS conformal coatings. Because each coating maintains its own unique properties and every application requires specialized protection, SCS' sales and engineering teams stand ready to help customers select the best coating for their specific application based on environmental and performance requirements.

BARRIER PROPERTIES

SCS conformal coatings provide excellent moisture barrier, chemical barrier and electrical isolation properties that protect automotive components against corrosive liquids, fluids, gases and chemicals, even at elevated temperatures. While several conformal coating variants offer similar properties, Parylene HT stands out for the specific protection it offers the automotive industry.

Table 1 shows that Parylene HT films minimally swelled with exposure to automotive chemicals and fluids; however, the swelling completely reversed after the solvents were removed by vacuum drying.

Parylene HT-coated circuit boards were also salt-fog tested by an independent facility and showed no corrosion or salt deposits after 144 hours of exposure in accordance to ASTM B117-(03) (See Figure 1).

DIELECTRIC & ELECTRICAL ISOLATION PROPERTIES

The dielectric properties of conformal coatings are key attributes for electrical and cooling systems found within electric and hybrid vehicles, semis, bikes and trains. Electrical isolation is critical during the transfer of high voltages, and conformal coatings provide great isolation at small thicknesses relative to other solutions. In addition, low dielectric constants and dissipation factors enable coatings to transfer electrical signals without absorption or loss.

THERMAL & UV STABILITY

In order for conformal coatings to successfully provide moisture, chemical or dielectric barrier protection to automotive components, the coatings themselves must also survive the harsh environments these applications encounter. Automotive operating environments often range from -40°C to more than 300°C. In addition, many applications also experience prolonged exposure to UV light.

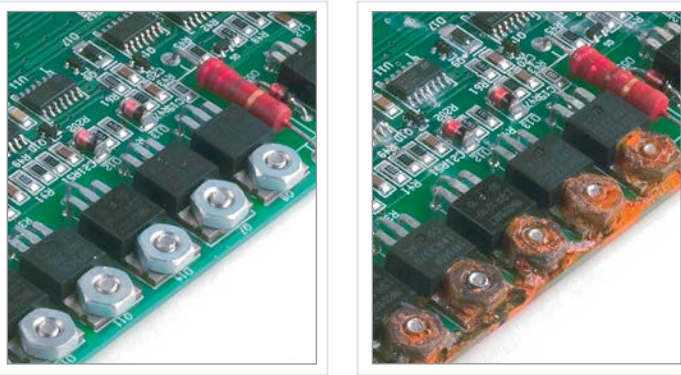
SCS coatings provide the thermal stability (up to 350°C long-term, 450°C short-term) necessary to ensure the trouble-free life of automotive electronics and system parts. Additionally, Parylene HT offers measurable UV stability after more than 2,000 hours of UV exposure (ASTM G154).

TABLE 1: Chemical and Fluid Resistance of Parylene HT

Chemical	Parylene HT Film Swelling
Automotive Fluids Heated to 90°C Antifreeze — 50% solution Engine Oil — 10W30 Transmission Fluid — Dexron III 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%

*Contact SCS for testing parameters.

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



Coated with SCS Parylene HT

Uncoated

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. Conformal coatings have been shown to suppress the formation of metallic whiskers, OSEs (odd shape eruptions) and dendrites.

USEFUL IN MANY AUTOMOTIVE APPLICATIONS

Due to the continued and rapid growth of advanced electronic systems, the automotive industry has evolved greatly over recent years. The industry, which used to rely heavily on mechanical systems, not only has increased in its use of electronic systems, but now includes new interpretations of autonomous vehicles and propulsion systems (e.g., electric, hybrid and fuel cell technologies). These advances are present not only in consumer vehicles but also in construction equipment, buses, heavy-duty trucks, ships, electric bikes and agriculture machinery. Today, electronic systems no longer work as independent components but, rather, as fully integrated systems that use sensors, MEMS and radar to control autonomous vehicles on the road.

BATTERY MANAGEMENT SYSTEMS (BMS)

As the world transitions toward electric vehicles (EV), conformal coatings are playing a key role in ensuring the reliability of critical vehicle systems. BMS, such as liquid cooling or immersive cooling systems, help to maintain optimal operating temperatures but, while doing so, challenge the functionality of electronics and components. OEMs and Tier 1 suppliers rely on conformal coatings to provide chemical resistance, moisture barrier protection and electrical isolation to mitigate the risk of failure within these critical systems.

SENSORS

Modern vehicle systems rely on sensors to monitor the accuracy and operation of safety features, moving parts,

fluid levels, temperatures and various pressures. Further, autonomous vehicles depend on sensors to control and monitor the exact placement of a vehicle on the roadway. Conformal coatings' barrier properties are frequently relied on to protect critical sensors from harsh chemicals, fluids and gases.

ELECTRIC, HYBRID AND FUEL CELL TECHNOLOGIES

Many major automotive companies have developed electric and hybrid vehicles that generate and utilize electricity to reduce the world's reliance on oil for fuel. Conformal coatings offer exceptional dielectric properties, ensuring that the high level of power required for operating these electronic systems will not be weakened or distorted. Power inverters often rely on conformal coatings for their moisture barrier and electrical isolation properties. Additionally, conformal coatings are being increasingly used by EV charging station manufacturers due to harsh outdoor conditions that impact the functionality of these stations and vehicle charging connectors.

Fuel cells operate in the midst of corrosive compounds at elevated temperatures, a very harsh environment for electronics. A selection of conformal coatings, including Parylene HT and HumiSeal® UV40, are chemically structured to provide superior protection for these components.



MEMS

Micro-Electro-Mechanical Systems (MEMS) continue to represent the cutting-edge of vehicle innovation, often replacing previous generation single-sensors. Today's multi-capacity MEMS packages can be found controlling critical systems, including engine management, safety and security, tire pressure monitoring (TPMS), electronic stability, fluid pressure, fuel injection, pedestrian protection and radar systems. Ultra-thin conformal coatings and nanocoatings are ideal to protect complex MEMS wafers.

CIRCUIT BOARDS

The uniform nature of conformal coatings ensures complete coverage of circuit boards to protect against the ingress of moisture that causes corrosion. While each coating's application method and resulting thickness is unique, vapor-deposited and PECVD-deposited coatings are extremely lightweight, adding very little mass to even the smallest of circuit boards used in engine management systems, electronic control units (ECUs), torque sensors, power inverters, BMS and emission systems.

INNOVATIVE SOLUTIONS FROM THE LEADER IN CONFORMAL COATINGS

With over 50 years of experience in conformal coating engineering and applications, Specialty Coating Systems (SCS) is the world leader in Parylene, liquid, plasma polymerized, ALD and multilayer 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 conformal coating specialists, highly experienced sales engineers and expert manufacturing personnel, working in state-of-the-art coating facilities around the world. 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.

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

- AS/EN 9100 and ISO 9001 certifications
- Production Parts Approval Process (PPAP)
- Nadcap® accreditation
- Requirements of IPC-CC-830
- QPL for MIL-I-46058C
- UL (QMJU2) recognized coatings
- Listings in the International Aerospace Database (OASIS)
- REACH and RoHS compliance

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



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