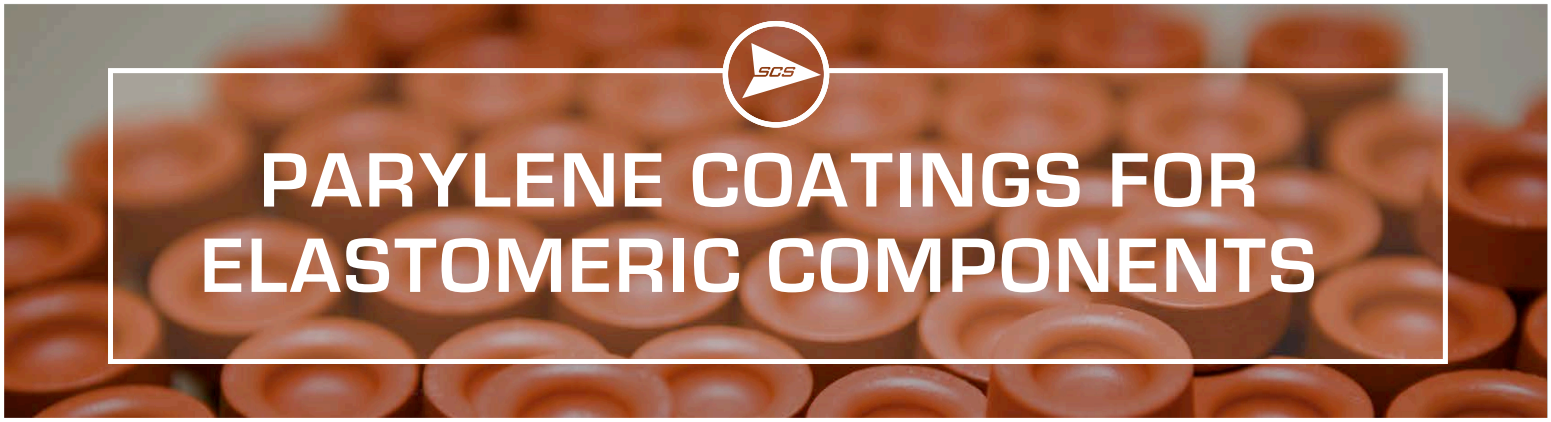


PARYLENE COATINGS FOR ELASTOMERIC COMPONENTS

SCS PARYLENE COATINGS

Ultra-thin and biocompatible, SCS Parylene conformal coatings provide excellent protection and surface properties to a number of elastomeric applications in the medical device, electronics, transportation, aerospace and defense industries.

Seals, O-rings, gaskets, stoppers and plungers are just a few of the elastomeric components that benefit from the properties that Parylene coatings offer. Tests completed per ASTM D 1894 indicate nearly identical static and dynamic coefficients of friction (COF) for Parylene HT® at 0.15 and 0.13, Parylene N at 0.25 and 0.25, and Parylene C at 0.29 and 0.29. With a COF near that of PTFE (Figure 1), Parylene coatings provide dry-film lubricity to a range of applications.

Engineers across industries also use conformal coatings to provide a barrier against the leaching of detrimental materials or elements contained in the elastomer. These barrier properties are demonstrated in a series of experiments with coated and uncoated rubber specimens. The specimens were autoclaved for one hour in one molar hydrochloric acid. The acid extracts were then analyzed for metals known to be present in the rubber's additive systems: calcium, aluminum and zinc. Figure 2 clearly shows that Parylene coating the test specimens markedly decreased extraction of these metals. Parylene coatings also protect surfaces from organic solvents and inorganic reagents, acids and solutions, and serve as a barrier to tie down particulates.

STERILIZATION OF PARYLENES

Parylene coatings are used to protect a wide variety of devices and substrates, including objects that must be sterilized on a one-time basis and those requiring repeated sterilization. SCS contracted with independent laboratories to test the most commonly used sterilization methods to determine the impact of these procedures on the coating. This proprietary research serves as a useful resource for customers in their evaluation of SCS Parylene coating technologies.

Tested sterilization methods included steam autoclave, gamma and e-beam irradiation, hydrogen peroxide plasma, and ethylene oxide; post-sterilization analysis evaluated the impact of these sterilizing agents on Parylenes N, C and Parylene HT samples against unsterilized control samples. Contact SCS for specific test results.

BENEFITS OF PARYLENE COATINGS:

- Ultra-thin and conformal
- Biocompatible and biostable
- Dry-film lubricity
- Reduces surface tack and stickiness
- Protection from oils, dirt and contamination
- Prevents flaking or dusting of the elastomeric surface
- Excellent moisture and chemical barrier
- Renders surfaces easy to clean
- Drop-in replacement for silicone oils

FIGURE 1: Coefficient of friction measurements for Parylene-coated rubber specimens.

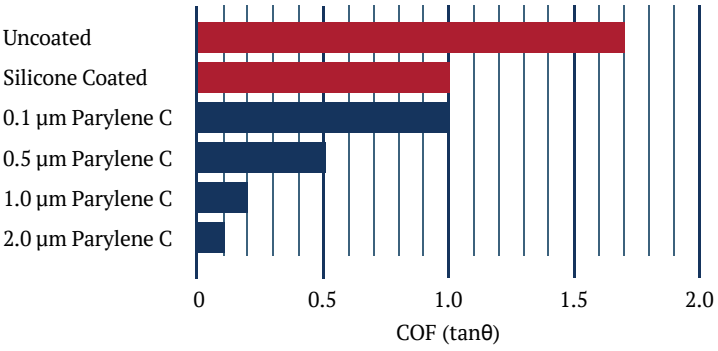
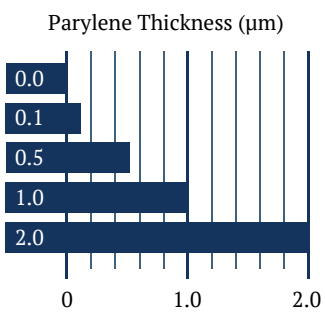


FIGURE 2: The effect of Parylene C coating thickness on extractable metals in rubber specimens.



Parylene Thickness (µm)	Calcium (ppm)	Aluminum (ppm)	Zinc (ppm)
0.0	0.17	4.2	50
0.1	0.15	1.8	35
0.5	0.03	0.1	12
1.0	<0.002	<0.05	0.2
2.0	<0.002	<0.05	<0.05

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BIOLOGICAL PERFORMANCE OF PARYLENES

SCS Parylenes N, C and Parylene HT have been tested according to the biological evaluation requirements of ISO-10993 for those tests indicated in Table 1. Further, the biocompatibility and biostability of SCS Parylenes have been demonstrated in a wide range of medical coating applications over the past three decades.[1,2,3]

TABLE 1: ISO-10993 Biological Evaluations

	SCS Parylene Variant		
Tests	**N**	**C**	**Parylene HT**
Cytotoxicity	✓	✓	✓
Sensitization	✓	✓	✓
Intracutaneous Reactivity	✓	✓	✓
Acute Systemic Toxicity	✓	✓	✓
Implantation (2 weeks)	✓	✓	✓
Implantation (12 weeks)	✓	✓	✓
Implantation (26 weeks)	✓	✓	✓
Hemolysis	✓	✓	✓
Lee–White Clotting Time	✓	✓	✓
Pyrogenicity	✓	✓	✓

THE PARYLENE DEPOSITION PROCESS

Parylenes are applied at ambient temperatures via a vapor deposition polymerization process, wherein coating occurs at the molecular level with ultra-thin films essentially growing a molecule at a time. Parts are housed in the system's deposition chamber, which remains at room temperature throughout the entire Parylene coating process. Batch sizes range from hundreds to tens of thousands of elastomeric components, resulting in a very cost-effective, highly functional coating solution.

Because Parylenes are applied as a gas, they provide complete and uniform encapsulation of parts. While Parylene coatings can range in thickness from hundreds of angstroms to several mils, a typical thickness for elastomeric components is in the 1-2 micron range.

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

REFERENCES

1. N. Stark. "Literature Review: Biological Safety of Parylene C." *Medical Plastics and Biomaterials* 3, no. 2, (1996): 30-35.
2. M. Kaminska, W. Okrój, W. Szymanski, W. Jakubowski, P. Komorowski, A. Nosal, H. Szymanowski, M. Gazicki-Lipman, H. Jerczynska, Z. Pawlowska, B. Walkowiak. "Interaction of Parylene C with Biological Objects." *Acta Bioengineering and Biomechanics* 11.3 (2009): 19-25.
3. "Kirk-Othmer Encyclopedia of Chemical Technology, 5th Edition." John Wiley & Sons, Inc. (2007).

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.

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