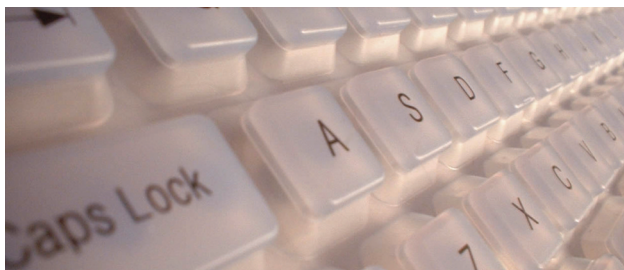


Parylene: Improving and Protecting Elastomer Components

- Dry film lubricity
- Pinhole-free
- Thoroughly conformal
- High surface bond strength
- Thickness consistency
- Chemical resistance
- Solvent resistance

Elastomers

Parylene's thin, transparent and flexible characteristics enhance the performance of rubber and elastomer components by protecting surfaces and modifying surface properties. These improvements are made without degrading the functional performance of the part. Parylene yields a truly conformal coated part with a consistent thickness on both flat surfaces and around the internal dimensions of openings and features as small as 0.01mm. Pinhole-free Parylene can prevent the transfer of substances into or out of a coated substrate. In particular, high molecular weight compounds such as silicone plasticizers are retained beneath the film barrier, and the coating also prevents solubilizing chemicals from intruding into an elastomer.



Lubricity, Elasticity, Resistance to Surface Wear

Objects coated with Parylene film include a diverse range of rubber and elastomer components, from gaskets and seals to keypads and medical catheters. During the vacuum deposition coating process, the Parylene monomer is able to penetrate the surface of rubbers and plastics, providing outstanding adhesion. A 2 micron coating imparts exceptional dry lubricity as well as resistance to surface wear. For example, silicone rubber keypads are coated to improve the 'feel' of the surface by removing the elastomer tack while protecting the keyboard against dirt and oils, and shielding printed legends.

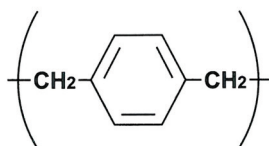
'O'-rings are coated to reduce friction in syringes. Parylene's static and dynamic coefficients of friction, which are in the range of 0.25 to 0.33, allow coated elastomers to approach the dry film lubricity of PTFE. Increased coating thicknesses further improve chemical and solvent resistance. Parylene film's elasticity and surface adhesion integrity enable the coating to accommodate elongation of the underlying elastomer without fracture or loss of the bond between the film and the substrate.

Enhanced Elastomer Performance

Properties of Parylene

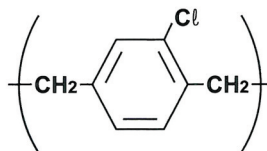
TYPICAL PHYSICAL & MECHANICAL PROPERTIES	Parylene N	Parylene C
Tensile strength, psi	6,500	10,000
Tensile strength, MPa	45	69
Yield strength, psi	6,300	8,000
Tensile strength, MPa	43	55
Tensile modulus, MPa	2,400	3,200
Elongation at break, %	40	200
Yield elongation, %	2.5	2.9
Density, g/cm ³	1.110	1.289
Coefficient of friction: Static	0.25	0.29
Dynamic	0.25	0.29
Water absorption: % (24hr)	0.01(.019")	0.06 (.029")
Index of refraction, n _D ²³	1.661	1.639
TYPICAL ELECTRICAL PROPERTIES	Parylene N	Parylene C
Dielectric strength, short time (Volts/mil at 1 mil)	7,000	6,800
Volume resistivity, 23°C, 50% RH (Ohm-cm)	1x10 ¹⁷	6x10 ¹⁶
Surface resistivity, 23°C, 50% RH (Ohm)	10 ¹⁵	10 ¹⁵
Dielectric constant: 60 Hz	2.65	3.15
1,000 Hz	2.65	3.10
1,000,000 Hz	2.65	2.95
Dissipation factor: 60Hz	0.0002	0.020
1,000 Hz	0.0002	0.019
1,000,000 Hz	0.0006	0.013
TYPICAL BARRIER PROPERTIES	Parylene N	Parylene C
GAS PERMEABILITY cm ³ - mil/100 in ² -24hr - atm (23°C)		
Nitrogen	7.7	0.95
Oxygen	30	7.1
Carbon dioxide	214	7.7
Hydrogen sulphide	795	13
Sulfur dioxide	1.89	11
Chlorine	74	0.35
MOISTURE VAPOR TRANSMISSION g-mil/100 in ² -24hr, 37°C, 90%RH	1.50	0.14
1 mil = 1/1000 in = 25.4 microns		
TYPICAL THERMAL PROPERTIES	Parylene N	Parylene C
Melting temperatures (°C)	410	290
Linear coefficient of expansion (10 ⁻⁵ /°C)	6.9	3.5
Thermal conductivity, @ 25°C watts/Meter.Kelvin	0.120	0.082

Parylene N



Where lubricity is needed

Parylene C



Excellent barrier protection

Fig. 1
Volume resistivity, 23°C, 50% RH (Ohm-cm)

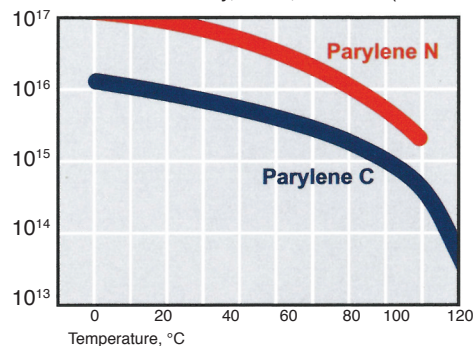


Fig. 2
Dielectric constant, 1,000 Hz

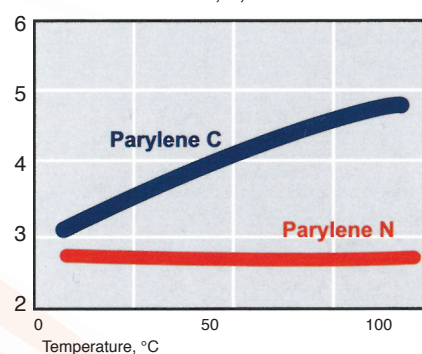
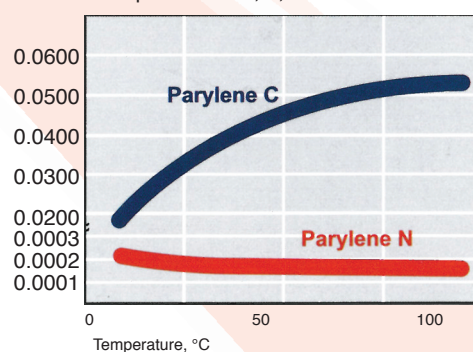


Fig. 3
Dissipation factor, 1,000 Hz



Results of a number of Parylene coating and Dimer studies are available on request. Additionally, we maintain device and drug master files with the US FDA. These files include the results of biological studies commissioned by CWST and are available for reference by commercial coating service customers.