Parylene Properties & Characteristics

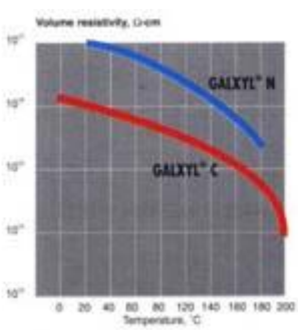
Parylene coatings are completely conformal, of uniform thickness and pinhole free. This is achieved by a unique vapor deposition polymerization process. The advantage of this process is that the coating forms from a gaseous monomer without an intermediate liquid stage. As a result, component configurations with sharp edges, points, flat surfaces, crevices or exposed internal surfaces are coated uniformly without voids.

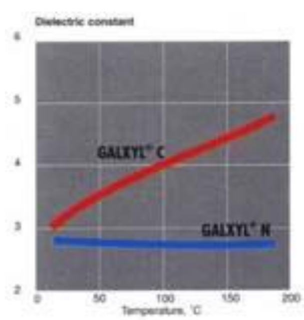
Properties

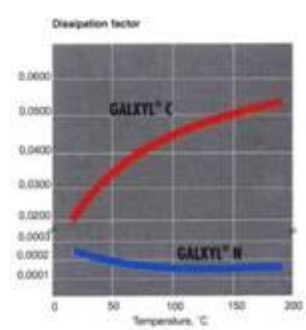
- High reliability - Suitable for military or commercial applications
- Light weight - Compared to other coatings
- Stress-free coatings - Sensitive circuitry unchanged by coating
- Low coefficient of friction - Use as a dry film lubricant
- Transparency - Thin films can be of optical quality
- Out-gassing - Virtually none
- Outstanding barrier - Very low permeability to moisture and gases
- Fungus and bacteria resistance - Excellent
- Mechanical - High tensile and yield strength
- Truly conformal - Uniform thickness on all surfaces
- Wide temperature range - From -200ºC to +200ºC
- Radiation resistance - Suitable for space applications
- Bio-compatible - Inertness invaluable for medical applications
- Particle retention - Upgrades electronic and mechanical devices
- Solvent resistance - Insoluble in common solvents
- Acid and base resistance - Resists attack from exposure
- Electrical breakdown - Extremely high dielectric strength

Typical Properties of GALXYL® Films Data recorded following appropriate ASTM methods.	**GALXYL® Parylene N**	**GALXYL® Parylene C**	**GALXYL® Parylene D**
Typical Physical & Mechanical Properties			
Tensile strength, psi	65,000	10,000	11,000
Tensile strength, MPa	45	69	76
Yield strength, psi	6,300	8,000	9,000
Yield strength, MPa	2,400	3,200	2,800
Elongation at break, %	40	200	10
Density, g/cm^3	1.110	1.289	1.418
Coefficient of friction: static	0.25	0.29	0.33
dynamic	0.25	0.29	0.31
Water absorption, % (24 hr)	0.01 (0.019")	0.06 (0.029")	
Index of refraction, n_D^{23}	1.661	1.639	1.669
Typical Electrical Properties			
Dielectric strength, short time (Volts/mil at 1 mil)	7,000	6,800	5,500
Volume resistivity, 23°C, 50% RH (Ohm-cm), see chart below	1x1017	6x1016	2x1016

Surface resistivity, 23°C, 50% RH (Ohm-cm)	1015	1015	5x1016
Dielectric constant: 60 Hz	2.65	3.15	2.84
1,000 Hz see chart below	2.65	3.10	2.82
1,000,000 Hz	2.65	2.95	2.80
Dissipation factor: 60Hz	0.0002	0.020	0.004
1,000 Hz see chart below	0.0002	0.019	0.003
1,000,000 Hz	0.0006	0.013	0.002
Typical Barrier Properties			
Gas Permeability *			
Nitrogen	7.7	0.95	4.5
Oxygen	30	7.1	32
Carbon dioxide	214	7.7	13
Hydrogen sulfide	795	13	1.45
Sulphur dioxide	1,890	11	4.75
Chlorine	74	0.35	0.55
Moisture Vapor Transmission**	1.50	0.14	0.25
* cm3-mil/100 in2-24hr-atm (23ºC) ** g-mil/100 in2-24hr, 37ºC, 90% RH 1 mil = 1/1000 in = 25.4 microns			
Typical Thermal Properties	7.7	0.95	4.5
Melting Temperature, (ºC)	410	290	380
Linear coefficient of expansion, (10-5 / ºC)	6.9	3.5	
Thermal conductivity, 10-4 (cal/sec)/(cm2 ºC/cm)	3	2	







Parylene is a vacuum deposited plastic film used to coat many types of substrates. These coatings provide excellent corrosion resistance, barrier properties and exhibit superior dielectric protection. Some items already benefiting from Parylene conformal coating include:

Accelerometers	Bobbins	Capacitors	Catheters	Circuit boards
Coils	Ferrite Cores	Disk Drive Components	Fiber Optic Components	Heat Exchangers
Hybrids	Keypads	Flow Meter Components	Magnets	Pacemakers
Wire	Probes	Photoelectric Cells	P.I.N.D. rejects	Relays
Semiconductors	Sensors	Transformers	Thermistors	Elastomerics

Understanding Parylene

Parylene, unlike other polymeric materials, is not manufactured or sold as a polymer, but rather is produced by vapor-phase deposition and polymerization of para-xylylene (or its substituted derivatives). A highly crystalline, straight-chain compound, parylene as a vacuum deposited plastic has the unique quality of coating in a completely uniform manner. Unlike dip or spray coatings, condensation coating does not run off or sag, is pinhole free, will not bridge, so that holes can be jacketed evenly, will conformally coat over edges, points, and internal areas. With parylene, the object to be coated remains at or near room temperature eliminating all risk of thermal damage. Masking can be used if desired on areas not to be coated.

Parylene is extremely resistant to chemical attack, exceptionally low in trace metal contamination, has superior dielectric strength (5000 volts/mil at 1 mil), a very low dissipation factor, excellent mechanical strength, very high surface and volume resistivities, and other superior electrical properties that remain virtually constant with changes in temperature.

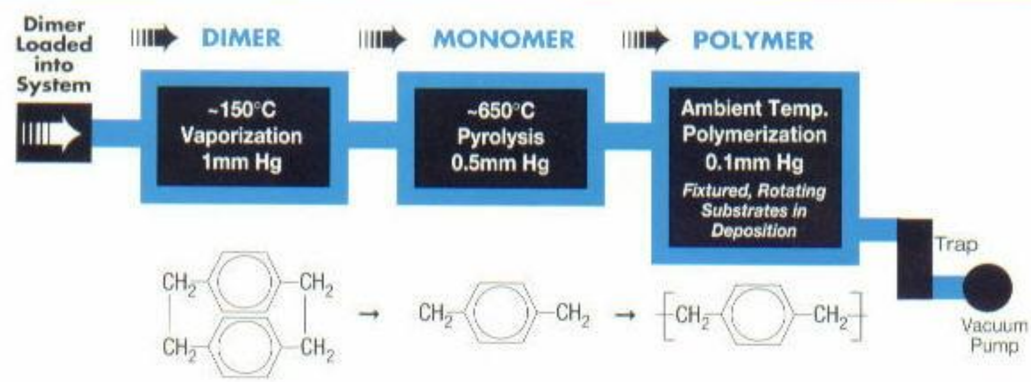
Parylene can simultaneously coat many small parts of varying configurations. In current commercial applications, parylene is deposited in thicknesses ranging from a few thousand angstroms to about 75 microns depending on the function the parylene film has to perform. Parts so small that they cannot be seen by the naked eye can be conformaly coated to thicknesses that can be controlled generally to plus or minus 10%. This provides physical barrier properties equal to or better than, the 2-6 mil thickness of epoxies, silicones, urethanes or other conventional coatings which generally require multiple applications to eliminate pinholes. Parylene requires no catalysts or solvents thus eliminating environmental concerns.

Because of very low coefficients of static and dynamic friction, that are virtually the same, parylene can serve as a "dry film" lubricant which aids greatly in devices such as miniature servo motors, where starting torque can be a problem.

Parylene N is poly-para-xylylene which exhibits all of the above characteristics in addition to the ability to be used at temperatures exceeding 220 degrees C in the absence of oxygen.

Parylene C is poly-monochoro-para-xylylene, and is the most widely used member of this unique polymer series due to its excellent barrier properties. Parylene C offers significantly lower permeability to moisture and gases, such as nitrogen, oxygen, carbon dioxide, hydrogen sulfide, sulfur dioxide and chlorine, while retaining excellent electrical properties.

Parylene Coating Process



Parylene is not produced or sold as a polymer. It is not practical to melt, extrude, mold or calender as with thermoplastics. Nor can it be applied from solvent systems. Actually, many of the advantages found in parylene coatings, unlike epoxies, urethanes or silicones are a direct result of the coating deposition process.

The parylene process is a relatively simple vacuum application system, that starts with a dimer, which is placed in a vacuum system and converted to a reactive vapor of the monomer. When passed over room temperature objects, this vapor will rapidly coat them with a polymer (note illustrations). The end result is an almost impervious uniform finish.