



# PARYLENE ENGINEERING

*For Longer Lasting Products*



# PARYLENE ENGINEERING

- This presentation serves as a **quick overview** of the conformal coating material and processes currently used in the industry.
- The field of conformal coating offers large amounts of specific information and data for each specific application and material.
- By presenting the major types of conformal coating materials and processes currently used in the industry, this presentation will help answer many general questions about conformal coating.



# TYPICAL PROCESS FLOW

1. RECEIVING
2. CLEANING
3. BAKING
4. MASKING
5. MASKING INSPECTION
6. FIXTURING
7. COATING
8. CLEANING
9. COATING INSPECTION
10. PACKAGING
11. SHIPPING



# GENERAL DEFINITION

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## *Conformal Coatings:*

Polymer coatings applied as a final step of the assembly process of circuit boards, medical devices, and elastomers; acting as a protective barrier from environmental elements.



# CONFORMAL COATING PURPOSE

- To provide an electrically insulated barrier to prevent effects of moisture and dust on an electrical circuit (denser circuit packaging, closer conductor spacing)
- To protect metals against corrosive effects
- Increase mechanical integrity from the effects from mechanical shock and vibration.
- Enhance performance and increase reliability



# SPECIFICATIONS & STANDARDS

- MIL-I-46058C Insulating Compound (electrical)
- MIL-P-28809 Printed wiring assemblies (includes accept / reject criteria for conformal coatings)
- IPC-CC-830 Qualification and Performance of Electrical Insulating Compounds
- UL 746C Polymeric materials, use in electrical equipment evaluations (UL requirements)
- J-STP-001 Requirements for soldered electrical and electronic assemblies (joint standard containing acceptance criteria for conformal coatings quality and qualification of conformal coated assemblies)



# APPLICATION METHODS

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- **Spray**
- **Brush**
- **Dip**
- **Gaseous Deposition**
- **Other Application Methods**
  - Spin Coating; Meniscus Flow or Wave Coating



# SPRAY COATINGS

Spraying, manual or automated, is the most popular and fastest method for applying conformal coating.

PRO'S	CON'S
<ul style="list-style-type: none"><li>✓ Fast</li><li>✓ Can be automated for high volume production</li></ul>	<ul style="list-style-type: none"><li>✓ Potential shadowing</li><li>✓ Use of solvents</li><li>✓ Potential for oil &amp; water contamination from spray equipment</li><li>✓ May need several coats</li><li>✓ Inconsistent edge thicknesses</li></ul>





# BRUSH APPLICATION

Brushing is the least efficient application method because of difficulty in achieving uniform coverage and controlling bubbling.

PRO'S	CON'S
<ul style="list-style-type: none"><li>✓ Fast</li><li>✓ Can be automated for high volume production</li></ul>	<ul style="list-style-type: none"><li>✓ Potential shadowing</li><li>✓ Use of solvents</li><li>✓ Potential for oil &amp; water contamination from spray equipment</li><li>✓ May need several coats</li><li>✓ Inconsistent edge thicknesses</li></ul>



# DIP APPLICATION

Dipping is a cost effective conformal coating process due to limited equipment needs. VOC disposal and contamination are potential issues.

PRO'S	CON'S
<ul style="list-style-type: none"><li>✓ Uniform coverage</li><li>✓ Repeatable film thickness</li><li>✓ Inexpensive equipment</li></ul>	<ul style="list-style-type: none"><li>✓ Trapped air</li><li>✓ Hazardous waste disposal</li><li>✓ Variable coating solution viscosity</li><li>✓ Coating build-up at bottom</li><li>✓ Use of solvents</li></ul>



# GASEOUS DEPOSITION

Gaseous deposition is the only process providing pinhole free coating at 0.5 mils or less – process will penetrate microscopic openings. Equipment cost are a prohibitive barrier to entry.

PRO'S	CON'S
<ul style="list-style-type: none"><li>✓ Uniform thickness</li><li>✓ Pin-hole free film</li><li>✓ Excellent penetrating characteristics</li><li>✓ Environmentally friendly process</li><li>✓ No cure cycle / fast turns</li></ul>	<ul style="list-style-type: none"><li>✓ Requires special equipment</li><li>✓ Need to batch process to be economical</li><li>✓ Masking could be labor intensive</li></ul>



# TYPES OF COATINGS

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- **Type AR - Acrylic Resin (Wet)**
- **Type ER - Epoxy Resin (Wet)**
- **Type UR - Urethane Resin (Wet)**
- **Type SR - Silicone Resin (Wet)**
- **Type XY – Parylene Polymer (Gas)**



# TYPE AR – ACRYLIC

- UV curable to accelerate cure cycles for exposed areas (may require second pass)
- Applied as liquid
- Typical 3-5 mils thickness
- Long shelf-life (1-year)
- Easiest to repair because easily stripped with alcohol or any other solvent
- Must be properly cured before placing in ESS testing. Time for optimum properties is 7 days.
- Subject to environmental regulations when VOC's for mixing
- Temp: -65°C up to 125°C



# TYPE EX – EPOXY

- Increases mechanical integrity of assembly
- Usually 2 component compounds
- Short pot life
- High abrasion and chemical resistance
- Extremely difficult to rework
- High shrinkage might crack some solder joints not desirable for most SMT assemblies
- Cure time 4-7 days at room temperature or 3 plus hours at elevated temperature
- Available in UV cure
- Temp: Up to 125C



# TYPE UR – POLYURETHANE

- UV curable to accelerate cure cycles for exposed areas (may require second pass)
- Applied as liquid 3-5 mils
- Must use a chemical stripper for rework (Burn-off with Soldering Iron)
- Susceptible to blistering caused by trapped moisture
- Time needed for optimum properties: 7 days up to 30 days. 1 component urethanes, 2 component UR faster
- Temps: -65°C to 125°C
- May crack if too thick (“alligator skin”)
- Require tight control of humidity during application i.e. if environment is too humid may form “champagne”-like bubbles
- Shelf life: 30 days to 12 months depending on formulations



# TYPE SR – SILICONE

- UV curable
- Applied as liquid 3-5 mils
- Up to 200°C
- Susceptible to abrasion (low cohesive strength)
- High coefficient of thermal expansion
- Repair difficult, do not vaporize with heat
- Chemical stripper compounds to dissolve silicone
- Limited Shelf life (6 months)
- Time for optimum properties: 7 days to 3 weeks



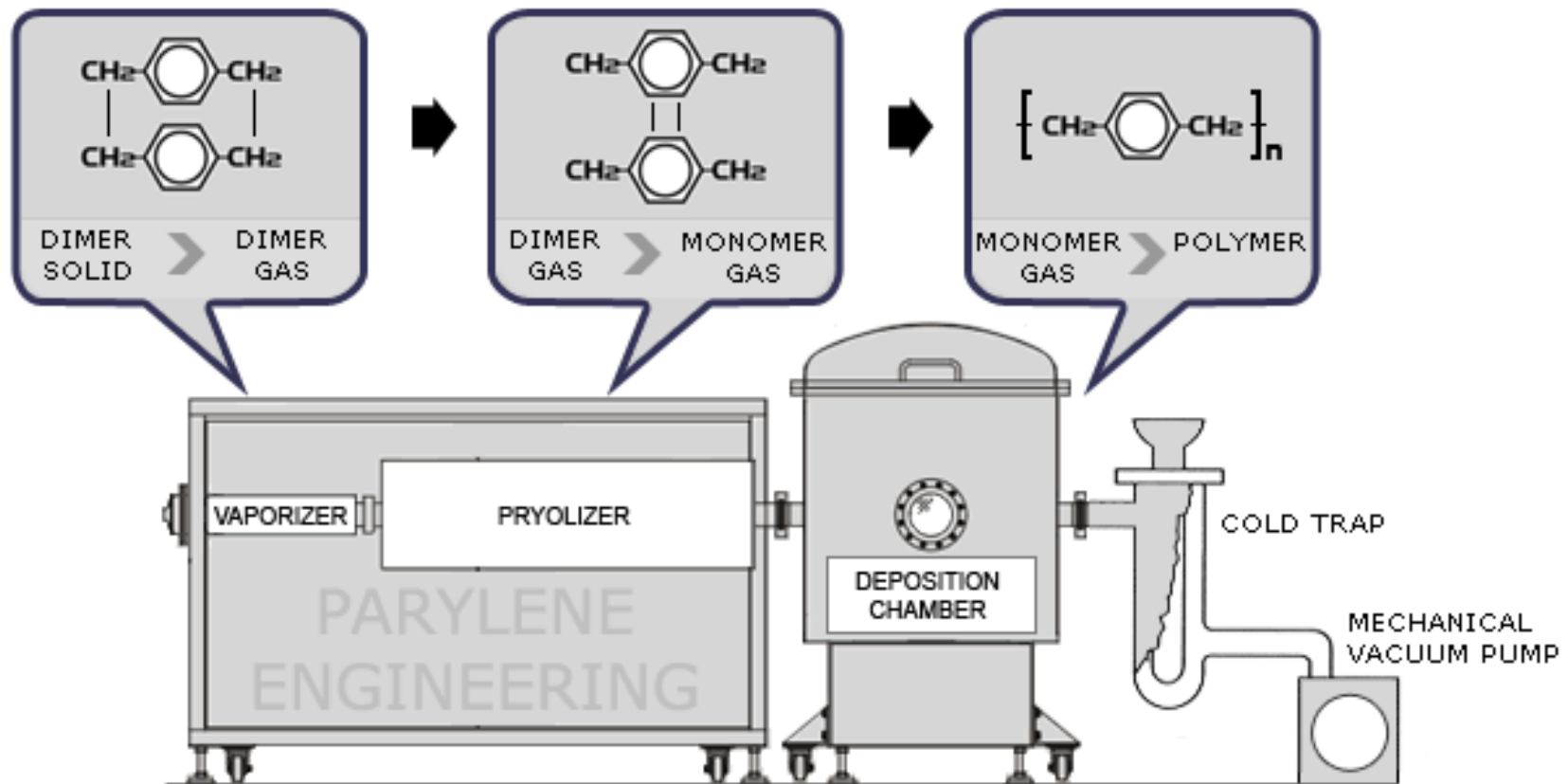


# TYPE XY – PARYLENE

- Applied in a vacuum environment as gaseous molecules that polymerize to form the film. No curing cycle
- Excellent penetration properties and high degree of uniformity total absence of pin holes
- High dielectric properties
- Low coefficient of friction (0.25)
- Need for special equipment
- Working temp: -200°C to 400+°C
- Applied at a 0.5 mil thickness
- Could have a 2 micron standing film for high tech applications
- Reparability by heat softening or mechanical abrasion
- FDA USP cat 5 approved (Human Implantable)
- No known shelf life



# PARYLENE PROCESS





# CURING

**Acrylic, Epoxy, Silicone, Urethane could be cured by:**

1. Evaporation of solvent
2. Use of catalysts at elevated temp.
3. Moisture at a min of 20% humidity
4. Exposure

➤ **Parylene: No curing cycle**



# PARYLENE FILM PROPERTIES

		C-Dimer	N-Dimer	ASTM
Density	g/cm <sup>3</sup>	1.309	1.110	D1505
Tensile Modulus	Gpa	3.2	2.4	D882
Tensile Strength	psi	9,800	6,800	D882
Yield Strength	psi	9,500	7,250	D882
Elongation to Break	%	270	30	D882
Yield Elongation	%	3.5	2.5	D882
Rockwell Hardness		R80	R85	D785
Coefficient of Friction		.29	.25	D1894
Melting Point	°C	290.7	420	
Dielectric Constant	60Hz	3.10	2.65	D150
	1KHz	2.83	2.65	
Dissipation Factor	60Hz	0.027	0.0002	D150
	1KHz	0.015	0.0002	
Dielectric Strength	Volts/mil	6,900	7,000	D149
Water Absorption (24hours)		<0.1	<0.1	D570



# PERFORMANCE CONSIDERATIONS

- Coating material selected must meet the performance requirements of coated item in worst case condition
- Consideration of material properties. (Thermal, Electrical, Mechanical) i.e.: High frequency circuits require low dielectric constant. High voltage circuits require higher dielectric strength. Shrinkage considerations for SMT or fine leads, types of components BGA or PGA for coverage, chemical considerations.



# APPLICATION CONSIDERATIONS

- Coating type
- Volume
- Cycle time
- Budget
- Masking & De-masking costs
- Wetting Characteristics
- Cure Characteristics
- Cost of coating material
- Personnel skill level needed, cost of training
- Safety and health issues, Code compliance
- Repair Characteristics



# PARYLENE APPLICATIONS

- **Surface Mount Devices (SMD's)**
  - Parylene is the most effective protection for this advanced packaging method. Parylene deposits at the molecular level, with superior penetration power to coat into, under, and around all components
- **Microelectronics**
  - Strong, stable, and secure, Parylene offers purity, maximum barrier protection, and total surface conformity
- **Hybrid Circuits**
  - Parylene strengthens wire bonds and eliminates moisture, metallic ions, and other contaminants. Military and aerospace organizations often use Parylene due to its reduced mass and weight.
- **Medical Devices**
  - Because Parylene coating provides a non-reactive, inert, pinhole-free barrier, it is perfect for use on biomedical instrumentation. Its strength and purity allows for functional utilization with body implant devices.
- **Circuit Board Coating**
  - Probably the most popular use for Parylene is its reliable application on circuit board assemblies. Qualified under MIL-46058C Type XY, Parylene will not alter resistor functions, thermocouples or other components.



# TIPS FOR DESIGNERS

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- Socketed IC's not desirable
- Watch for component spacing and placement
- Select back-sealed connectors, maximize use of male connectors
- Select sealed switches, pots, and relays
- Minimize use of test pins
- Use panels when possible





# MOVING FORWARD

- Facilities
- Web Presence
- Internal Systems
  - Database
  - Process Travelers
- Production FLOW





# FACILITIES

- 4,000 Square Feet (expanded from 2,400 at previous site)
- Separated 'machine' and 'production' sectors
- Enhanced FLOW visibility
- Designated inspection area
- 24 hour production schedule

**Willows Business Center**  
14842 NE 95<sup>TH</sup> Street  
Redmond, WA 98052  
[sales@paryleneengineering.com](mailto:sales@paryleneengineering.com)





# www.ParyleneEngineering.com



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SERVICES
APPLICATIONS
PROPERTIES
PROCESS
ABOUT US
CONTACT

PARYLENE ENGINEERING STRIVES TO PROVIDE 100% ON-TIME, DEFECT FREE, PARYLENE COATING SERVICES AND CONSULTATION - WHILE SIMULTANEOUSLY PRESERVING OUR ABILITY TO PROVIDE 24-HOUR TURNS.

 **DEFECT-FREE & 100% ON-TIME**

**COMMON APPLICATIONS**

- Circuit Boards
- Elastomers / Rubber
- Ferrite Cores
- Implantable Devices
- RFID Tags
- Medical Equipment
- Surgical Devices
- Microelectronics
- Hybrid Circuits
- Surface Mounted Devices
- High Voltage Units



<p><b>ELECTRONICS</b></p> <p>Parylene strengthens wire bonds and eliminates moisture, metallic ions, and other contaminants. Military and aerospace organizations often use Parylene due to its reduced mass and weight.</p> <p style="text-align: right;"><a href="#">more&gt;</a></p>	<p><b>MEDICAL</b></p> <p>Because Parylene coating provides a non-reactive, inert, pinhole-free barrier, it is perfect for use on biomedical instrumentation. Its strength and purity allows for functional utilization with body implant devices.</p> <p style="text-align: right;"><a href="#">more&gt;</a></p>	<p><b>EXTREME</b></p> <p>Parylene is a MIL-I-46058C and UL approved conformal coating. Parylene deposits at the molecular level, with superior penetration power to coat into, under, and around all components.</p> <p style="text-align: right;"><a href="#">more&gt;</a></p>	<p><b>NEWS &amp; UPDATES</b></p> <p><a href="#">We Moved!</a> Visit the contact page for updated contact information</p> <hr/> <p><b>OUR CUSTOMERS</b></p> <div style="text-align: center; font-size: 2em; font-weight: bold; margin-top: 10px;">  </div>
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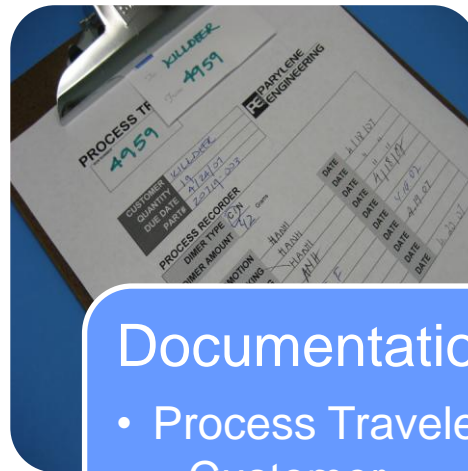


# PARYLENE PROCESS FLOW



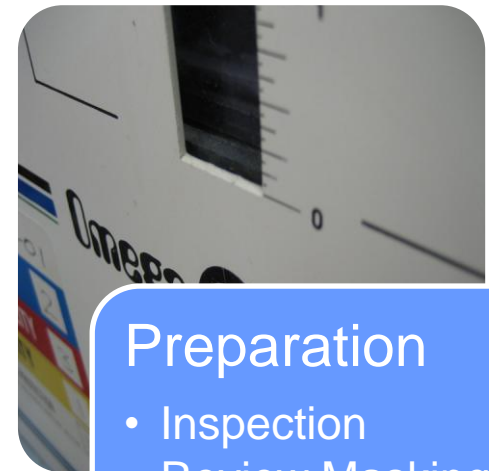
## Receiving

- Create Run#
- Verify Quantities
- Label Boxes
- Schedule Delivery



## Documentation

- Process Traveler
- Customer
- Quantity
- Part Number
- Due Date
- Strips Envelope



## Preparation

- Inspection
- Review Masking Requirements
- Promotion



# PARYLENE PROCESS FLOW



## Masking

- Method Document
- Board Protection
- How do we mask? Don't ask!



## Inspection

- Masking
- Contamination
- Damage



## Coating

- Fixturing
- Thickness Coupons



# PARYLENE PROCESS FLOW



## Demasking

- Proper Tools
- Proper Technique
- Proper safety precautions



## Inspection

- Masking Residue
- Damage



## Shipping

- Repackaging
- Shipping preference determined by customer
- Shipping on time!



# END OF PRESENTATION

## QUESTIONS?

### -MISSION STATEMENT-

Parylene Engineering aims to provide 100% on-time, defect free, parylene coating services and consultation; simultaneously striving to maintain our ability to provide 24-hours turn times while maintaining high standards - earning our customer's confidence