About Presenters

Terry Ng

- Lead Material Scientist at LPMS USA and a frequent presenter on material innovations for Low Pressure Molding Technologies.
- Member of IPC, WHMMA, American Chemical Society and the Society of Plastics Engineers. He is contributor to the IPC standards task group writing the 2023 updates for the technology.
- Led a cooperative effort among material suppliers to increase the use of additives and fillers to achieve material properties to meet tomorrow's demanding needs.
- University of Connecticut graduate with B.S.E. and M.S. in Materials Science and Engineering

Michael Pierce

- Lead Polymer Chemist at LPMS USA
- Considered one of the global experts in Low Pressure Molding Technologies with hot melt adhesives.
- Member of IPC task force that authored the first standards for Low Pressure Molding
- More than two decades at Henkel Corporation as a polymer chemist and LPM global technical leader.
- Michael is a member of IPC, WHMMA, American Chemical Society and the Society of Plastics Engineers.
- B.S. in Chemistry from Loyola University Chicago and an M.S. in Analytical Chemistry from Governors State University.

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Topic	Sub-Topic	Time (min)
I. Introduction		5
II. Electronic and Electronic Boards Protection		15
III. LPM Overview	Intro to LPM	10
	Materials for LPM	5
	Process for LPM	10
IV. Applications for LPM		5
V. Case Studies		5
VI. Conclusion		5
Demo &		40
Q&A		20
	Total time	120 minutes

Reliability in Electronics: Encapsulation Techniques & Low Pressure Molding

- The Assembly Show South
- April 4, 2023

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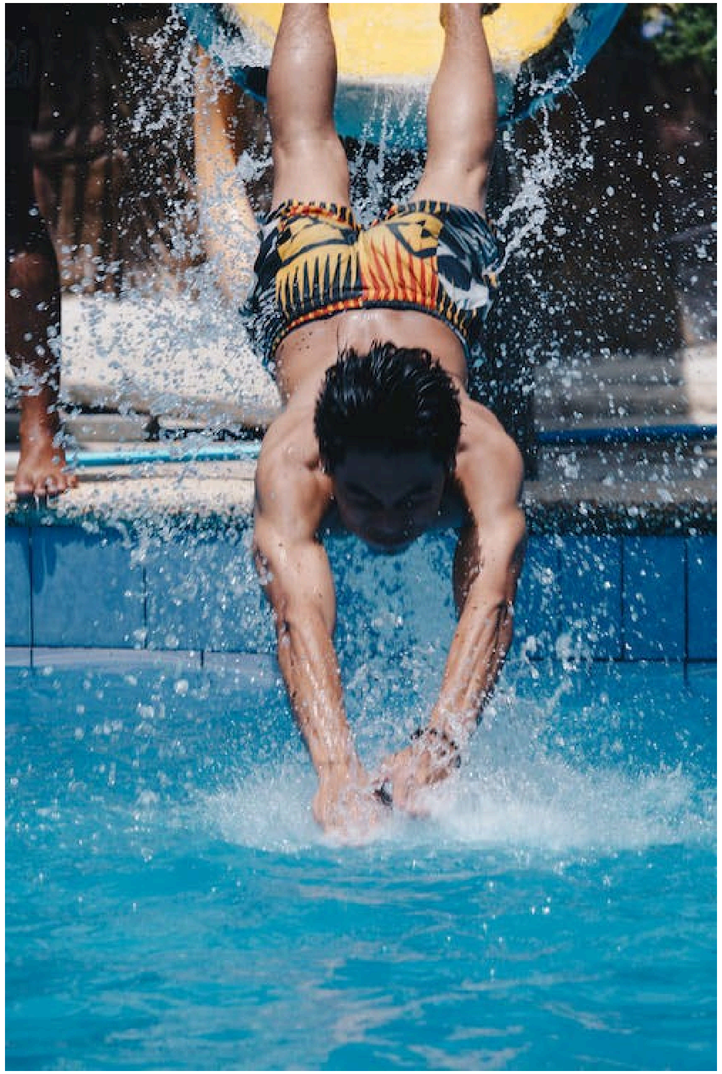
Why Protect Electronics?

- Safety
- Reliability
- Cost



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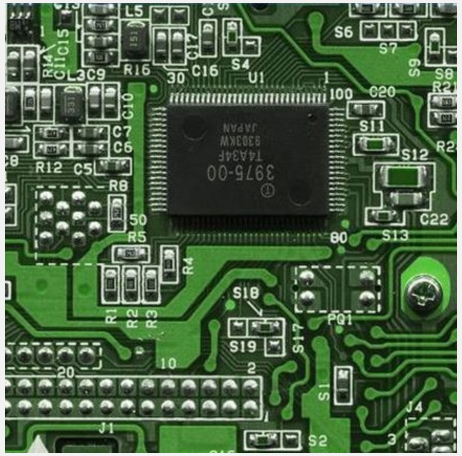
Electronics Protection

What happens without?

- Moisture damage
- Contamination
- Corrosion

Why do we need?



- Ensure reliability
- Environmental resistance
- Chemical resistance
- Cost of repair or replace

How can we protect?

- Clam Shell
- Potting
- Conformal Coating
- Gasket Sealing
- Low Pressure Molding

Level of Sealing

- Most products rated using the Ingress Protection (IP) scale
- Degrees of Protection:
  - First Number: protection against solids
  - Second Number: protection against liquids

1st Digit	Protection Against Solids	2nd Digit	Protection Against Liquids
0	No Protection	0	No Protection
1	50 mm Protected against solid objects greater than 50 mm	1	Protected against vertically falling drops of water
2	12 mm Protected against solid objects greater than 12 mm	2	Protected against direct sprays of water up to 15° from the vertical
3	2.5 mm Protected against solid objects greater than 2.5 mm	3	Protected against direct sprays of water up to 60° from the vertical
4	1 mm Protected against solid objects greater than 1 mm	4	Protected against water sprays from all directions - limited ingress permitted
5	Dust protected	5	Protected against low pressure jets of water from all directions - limited ingress permitted
6	Dust tight	6	Protected against strong pressure jets of water from all directions - limited ingress permitted
		7	Protected against water immersion between 15 cm and 1 m for a duration of 30 minutes
		8	Protected against continuous immersion in water
		9K	Protected against close-range, high pressure, high temperature spray downs

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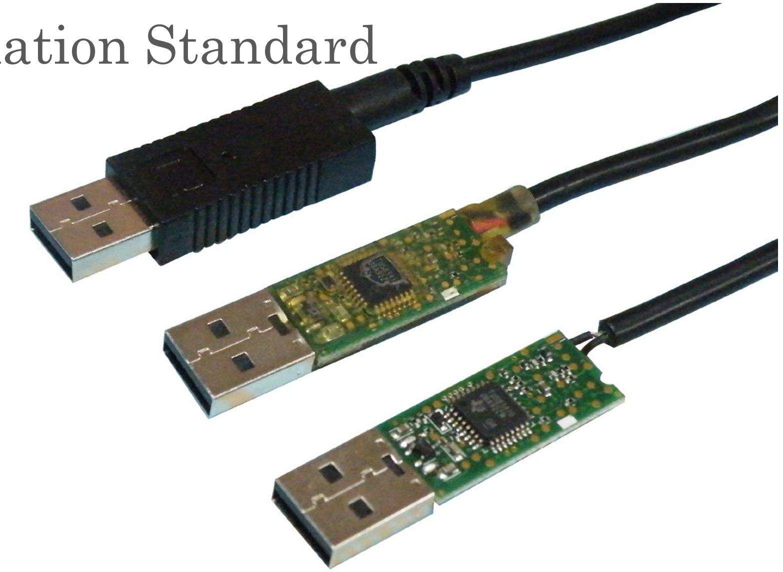
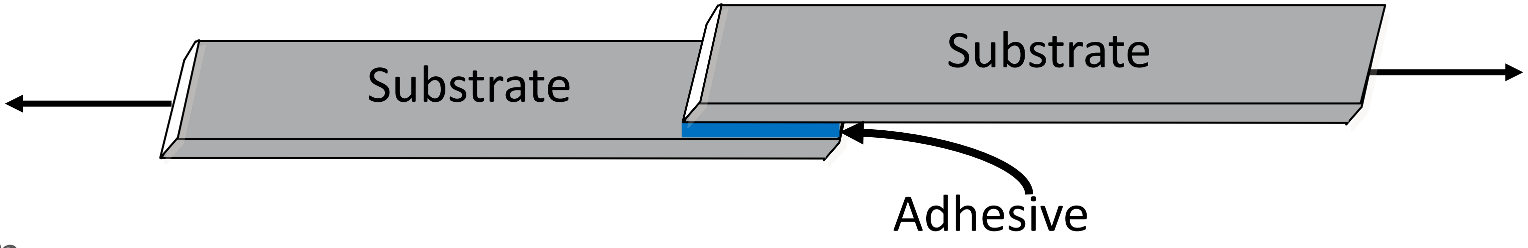
IPC Standards

- Standard for Potting and Encapsulation
- IPC 7621 standard for Low Pressure Molding
  - Created in 2013
- IPC HDBK 850 historical Potting and Encapsulation Standard
  - 2023 update will encompass updated IPC 7621



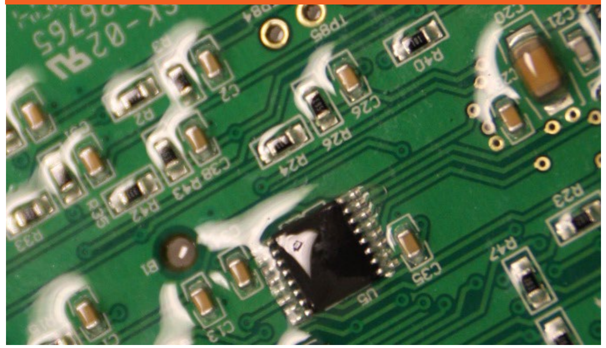
What's Different?

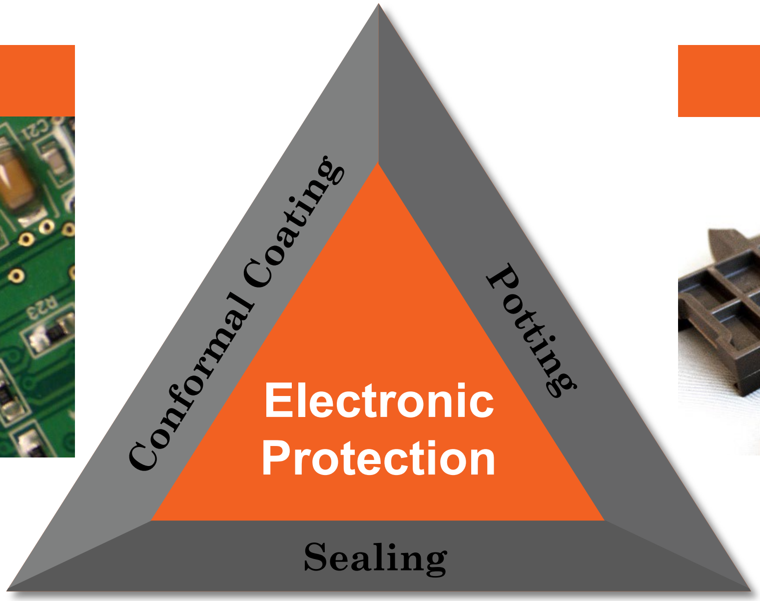
- Dispense style
- Time
- Energy consumption
- Chemical
- Adhesion
    - Enclosure
    - Mechanical bond
    - Chemical bond



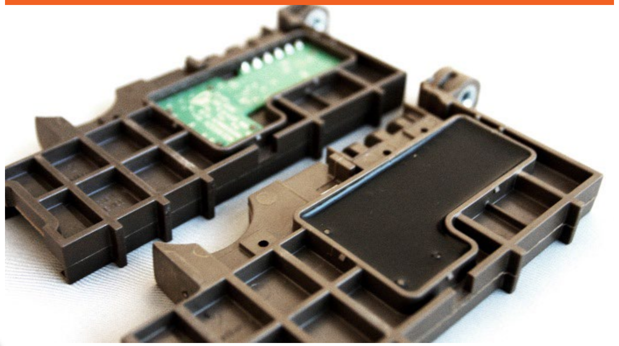
Traditional Methods

Conformal Coating





Potting



Sealing

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What is the Right Technology for you?

- Understanding the surface
- Understanding the IP rating
- Aesthetic requirements
- Weight, colors, feel
- Cost

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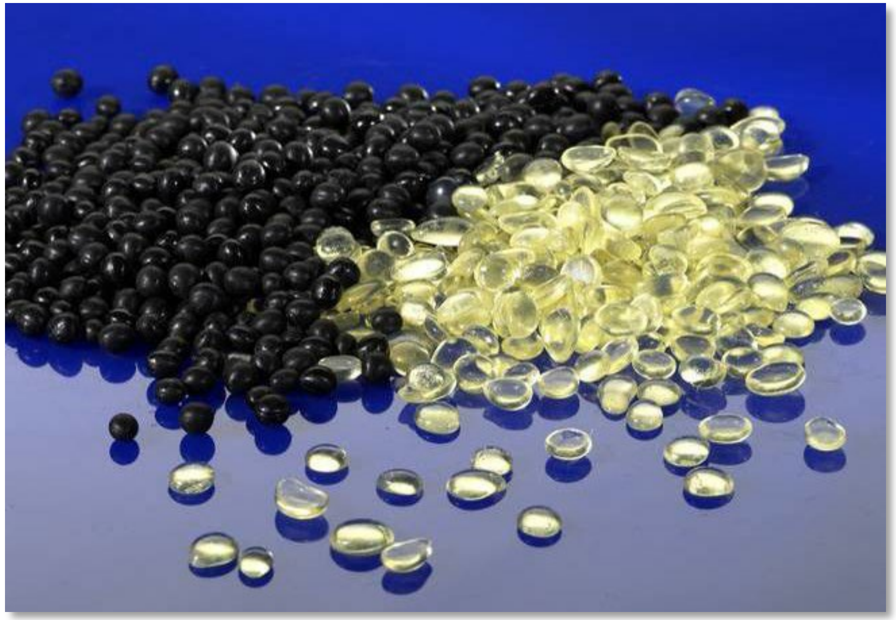
Adhesives

- Acrylic adhesives
- Epoxy adhesives
- Cyanoacrylate adhesives
- Polyurethane adhesives
- Silicone adhesives
- Heat-activated adhesives
- Low pressure molding (LPM) adhesives



The LPM method

- LPM saves your rice for eating, not drying!

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But I don't want to be the first one to try…

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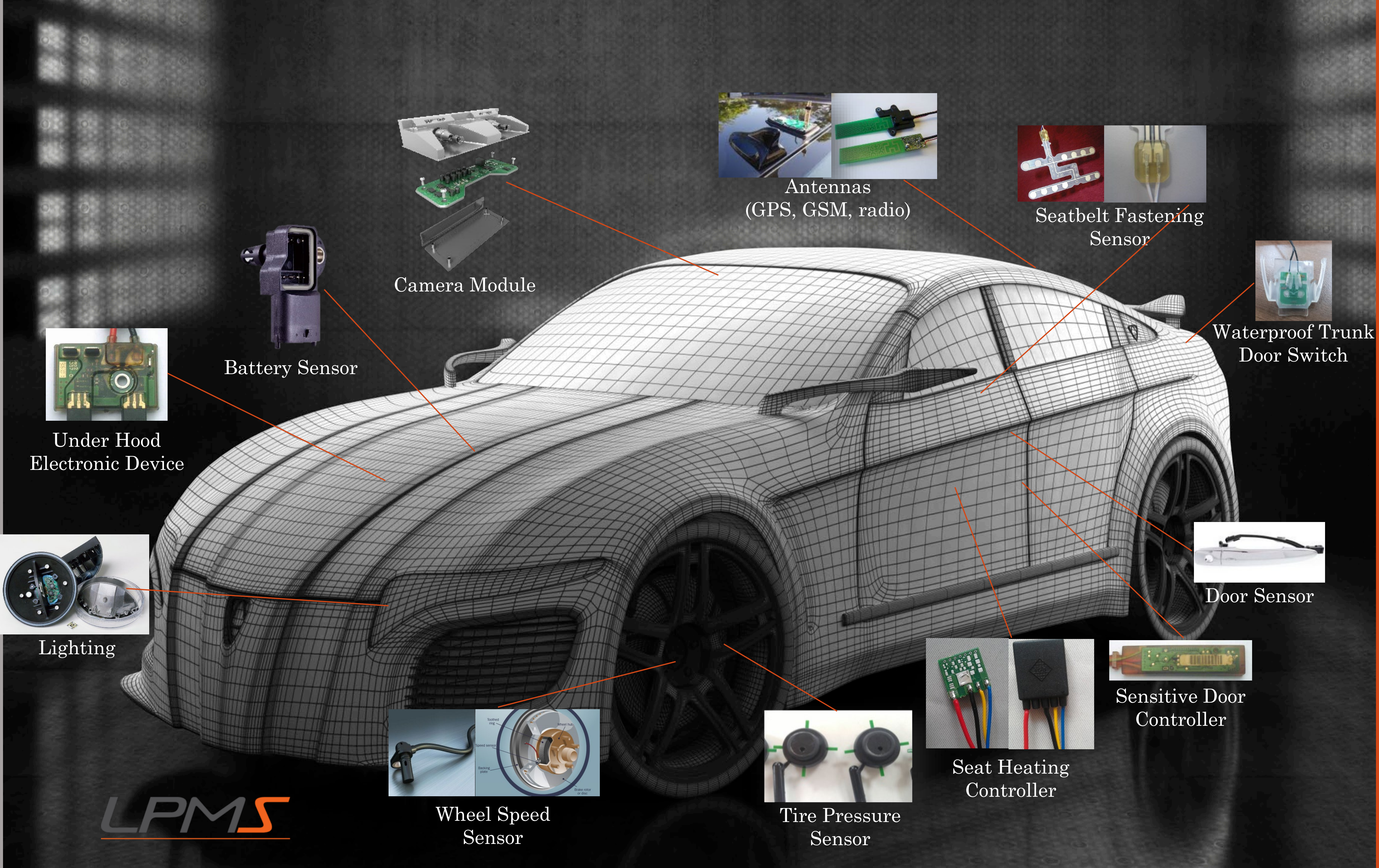
Camera Module
Antennas
(GPS, GSM, radio)
Seatbelt Fastening
Sensor
Battery Sensor
Waterproof Trunk
Door Switch
Under Hood
Electronic Device
Lighting
Door Sensor
Sensitive Door
Controller
Seat Heating
Controller
Wheel Speed
Sensor
Tire Pressure
Sensor
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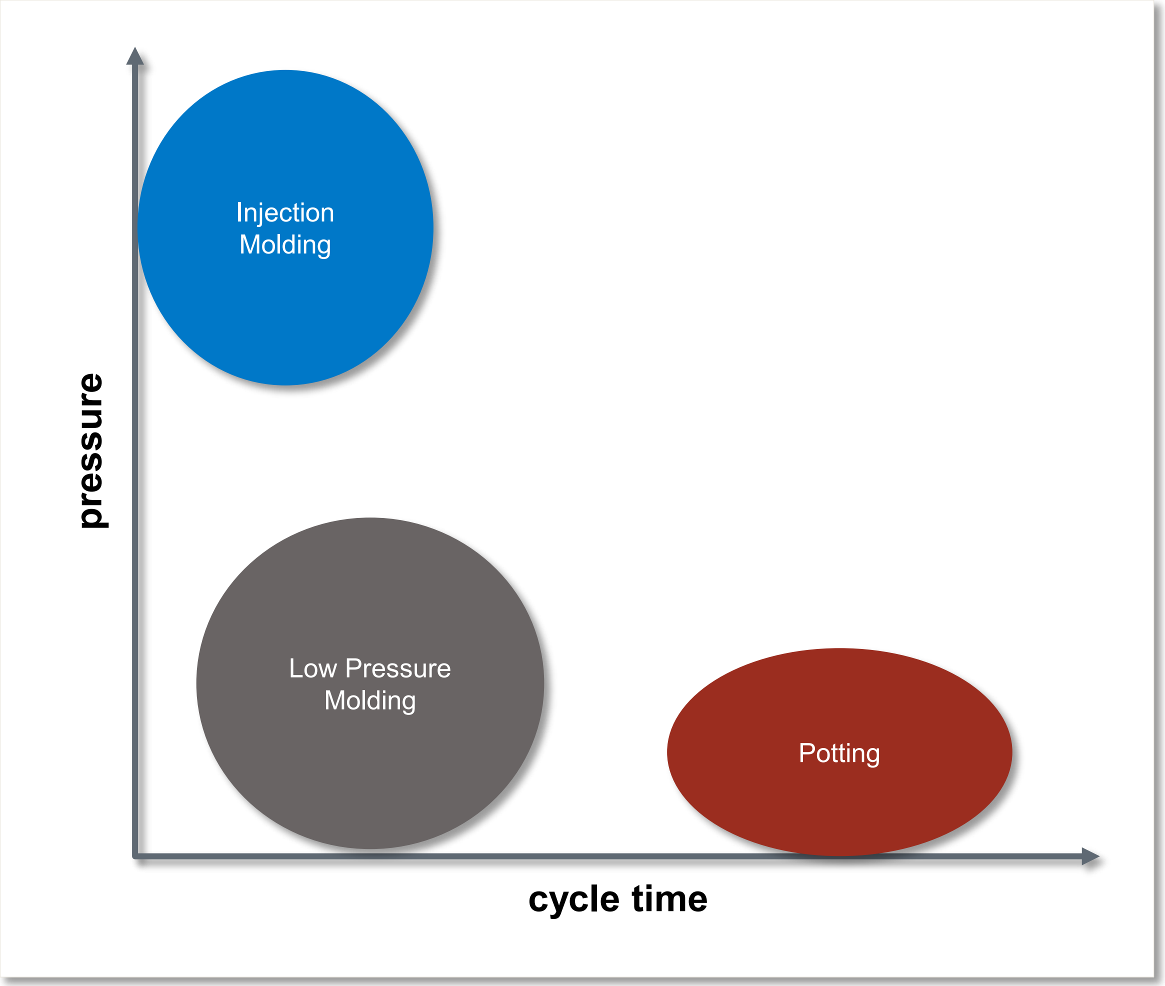
LPM Compared to the other Technologies

- Hotmelt adhesive!
- Doesn't need to cure
- Reworkable
- Cost effective
- Structural
- Non-hazardous
  - REACH
  - RoHS
  - Prop 65
  - no VOC



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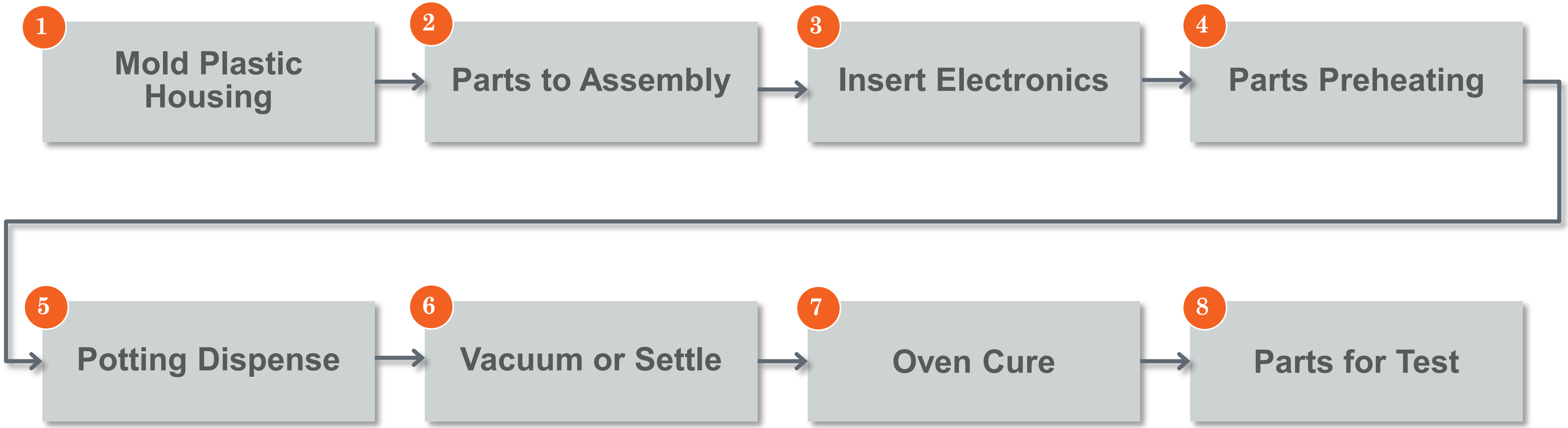
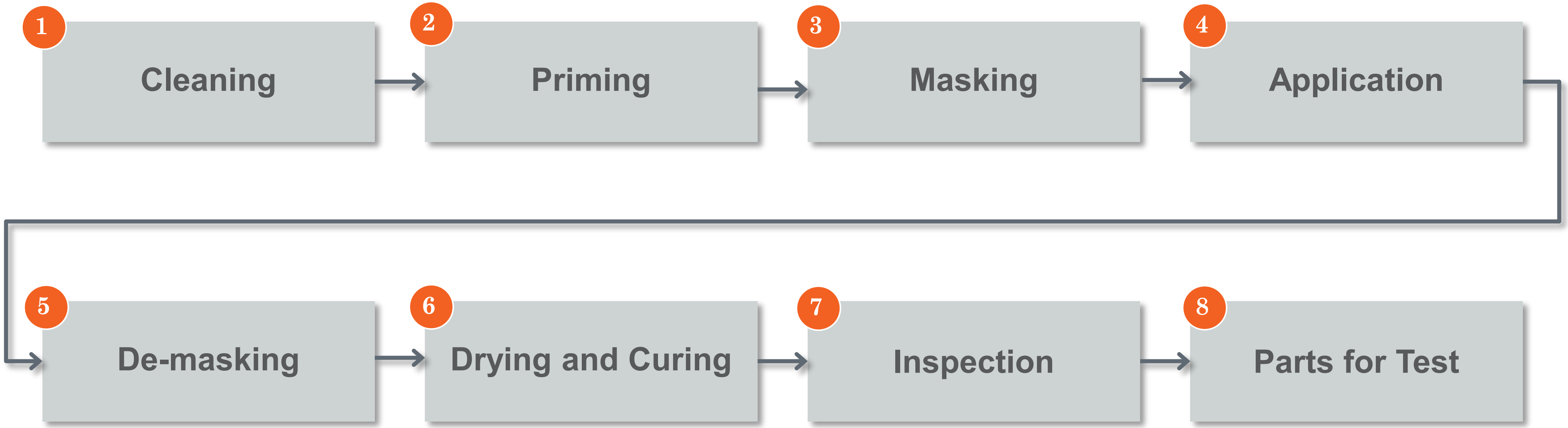
Potting Process Flow



Conformal Coating Process Flow



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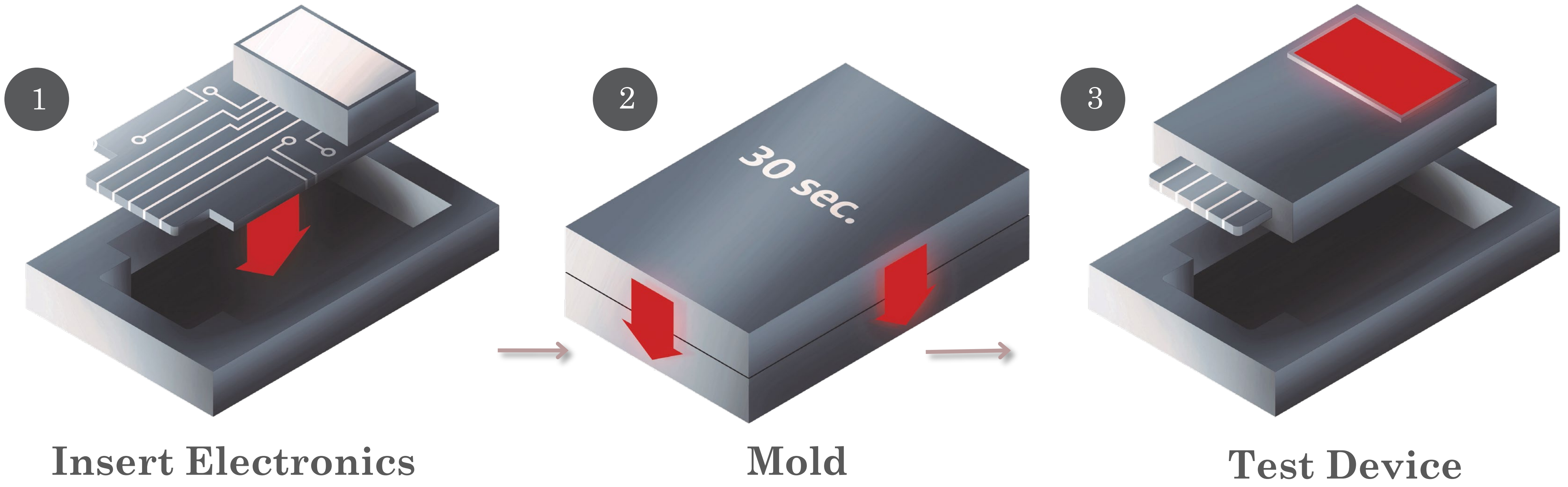
LPM Process Flow



Materials used in LPM

- **Polyamide**
  - -40 to 150°C
- **Polyolefin**
  - Low hygroscopic
- **Polyester**
  - Low temp flexibility, rubber-like
- Greener technology
- Renewable resources
- Lower carbon footprint
- Smaller waste stream

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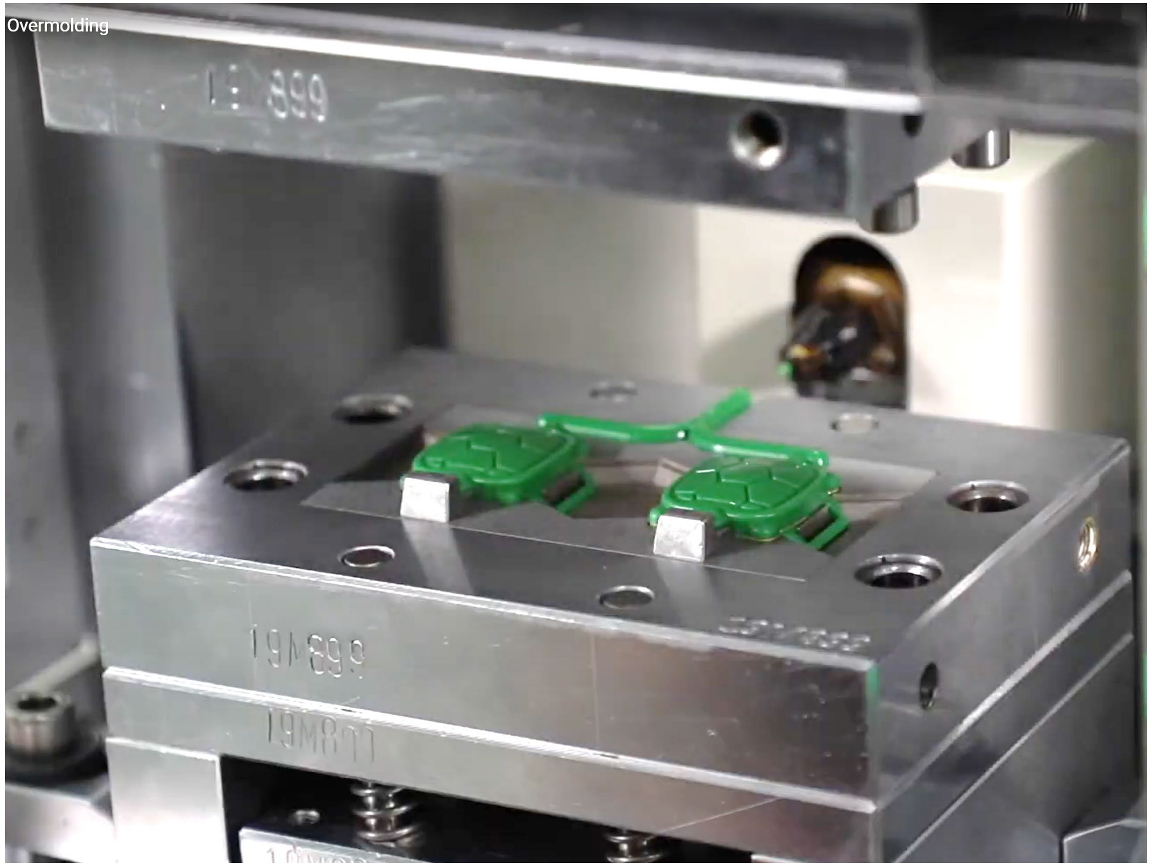
Equipment

- Static melt tank
- Gear pump technology
    - Low viscosity
- Small equipment footprint
- Horizontal/vertical machines
- Multiple nozzle optional

LPM molding video



Low pressure molding of a turtle

Bay Bridge in San Francisco

Situation

1000s of LED lights were installed on the bridge and programmed for a unique light show.

Challenge

- UV stable
- Resistance to salt, fog, humidity, wide range of weather conditions
- Waterproof
- Long operating life

Solution

- Excellent UV and thermal stability
- Resistance to salt, fog and humidity
- Exceptional adhesion

Disney Magic Bands

Situation

Disney World launched bracelets that stored guests' personal data and could be worn throughout an entire vacation.

Challenge

- Adhesion to flex circuit with RFID antenna and data chip
- Fast processing
- Water proof
- Humidity resistant
- Chemical resistant to soap, sunscreen, sweat, etc.

Solution

- High flexibility
- Good chemical and humidity resistance

Deep Water Horizon Oil Spill in the Gulf of Mexico

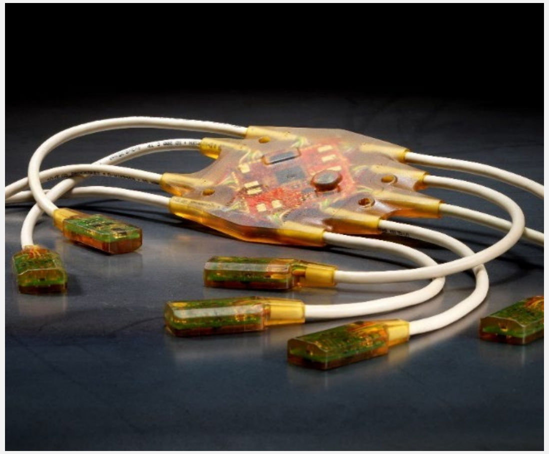
Situation

After a few failed attempts to seal the well, an ROV driller was deployed to repair the pipe and install a new blowout preventer to pump in heavy mud to kill the well. There were 10 individual PCBs that required encapsulation, including 9 robot arms.

Challenge

- Fluctuating pressure changes
  - Sustain 2,280 PSI for 3 days
- Salt water
- Hydrocarbon
- Low temperatures
- Mechanical stress and flexibility of robot
- Fast prototyping

Solution



- Best low temperature flexibility and chemical resistance
- High hardness and temperature resistance

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Reliability testing

USCAR
UNITED STATES COUNCIL FOR AUTOMOTIVE RESEARCH

FDA U.S. FOOD & DRUG ADMINISTRATION

SAE INTERNATIONAL™

UL

IPC®

MIL-STD 810H Certified

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A recap…

- Efficient
- Reliable
- Environmental friendly
- Cost effective

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Demonstration

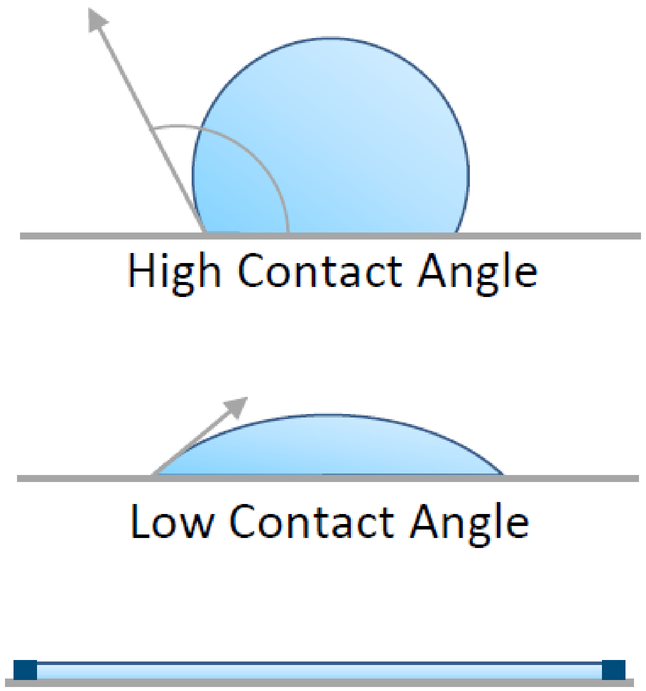
Question?

Adhesion Theory

- Mechanical theory: This theory explains adhesion as a result of mechanical interlocking between two surfaces. When two surfaces are brought into contact, their roughness and irregularities can interlock like two puzzle pieces, creating a bond.
- Electrostatic theory: This theory explains adhesion as a result of electrostatic forces between two surfaces. Opposite charges attract each other, so if two surfaces have different charges, they can be attracted to each other, creating a bond.
- Adsorption theory: This theory explains adhesion as a result of chemical bonding between two surfaces. When two surfaces are brought into contact, their molecules can interact chemically, creating a bond.
- Diffusion theory: This theory explains adhesion as a result of atoms or molecules diffusing between two surfaces. When two surfaces are brought into contact, the atoms or molecules in one surface can diffuse into the other surface, creating a bond.
- Wetting theory: This theory explains adhesion as a result of the ability of a liquid to spread over a surface. When a liquid is brought into contact with a surface, it can wet the surface, creating a bond.

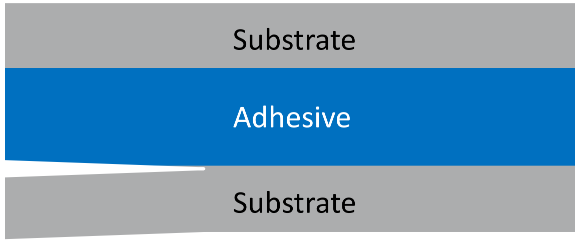
The Science of Surface

- Concept of wet out



Types of Failures

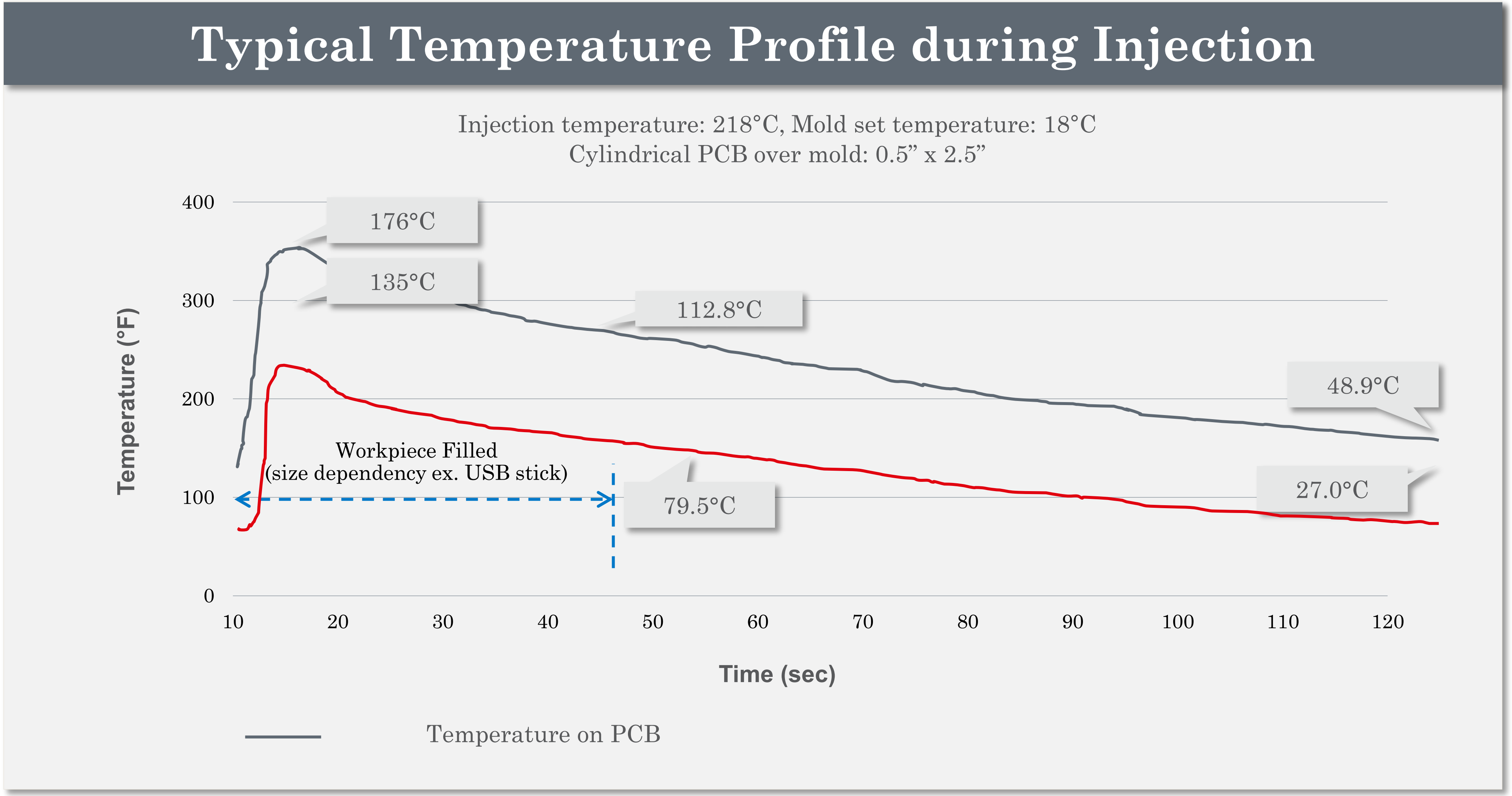
Cohesive Failure



Adhesive Failure

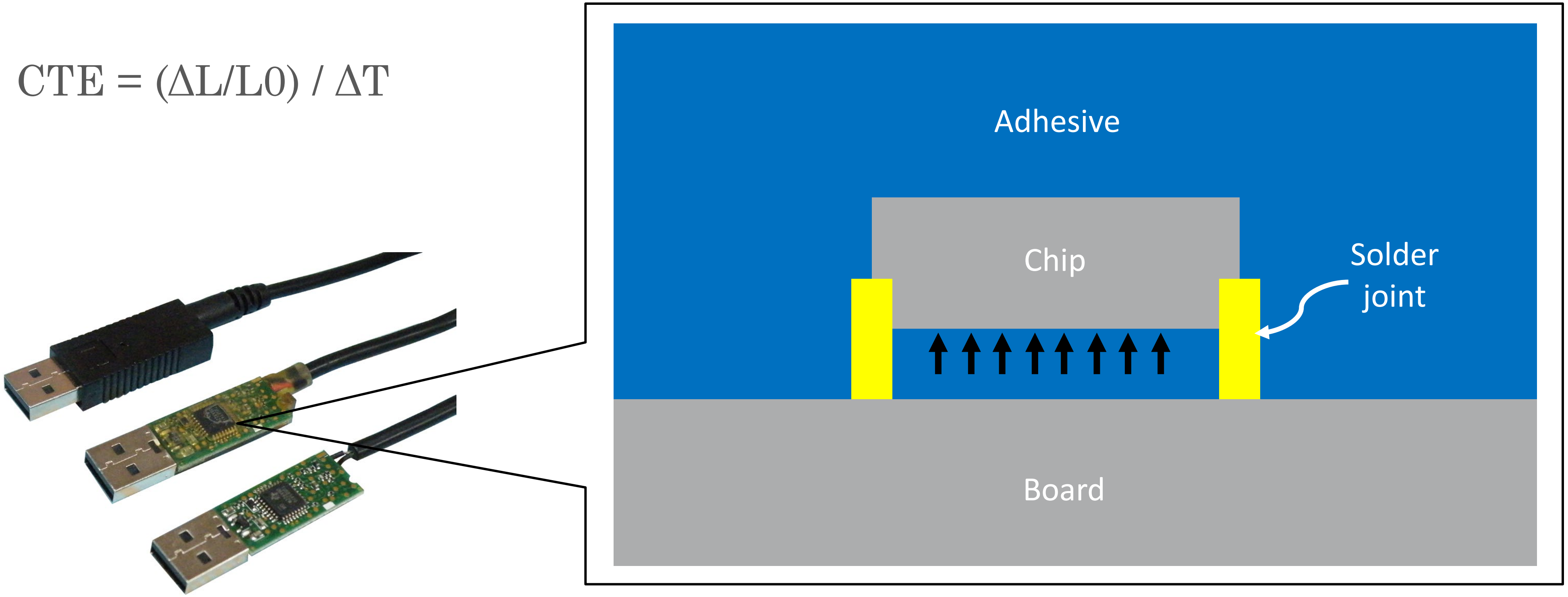
Substrate Failure

Inside the Mold

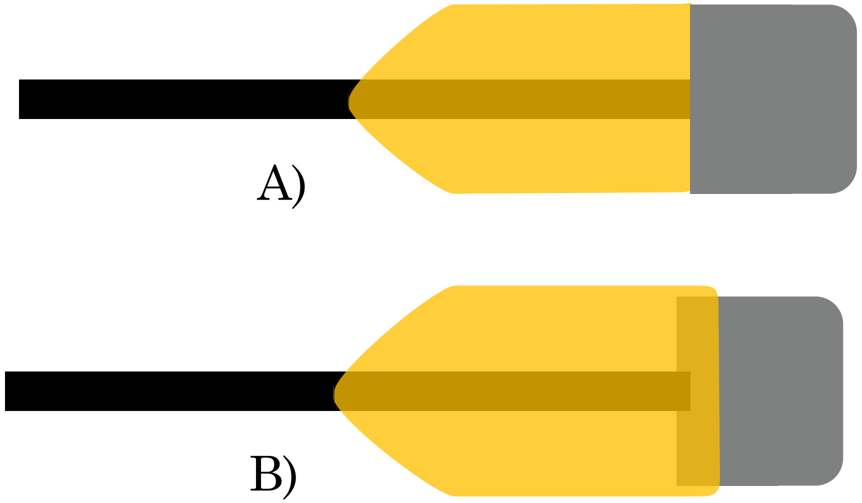


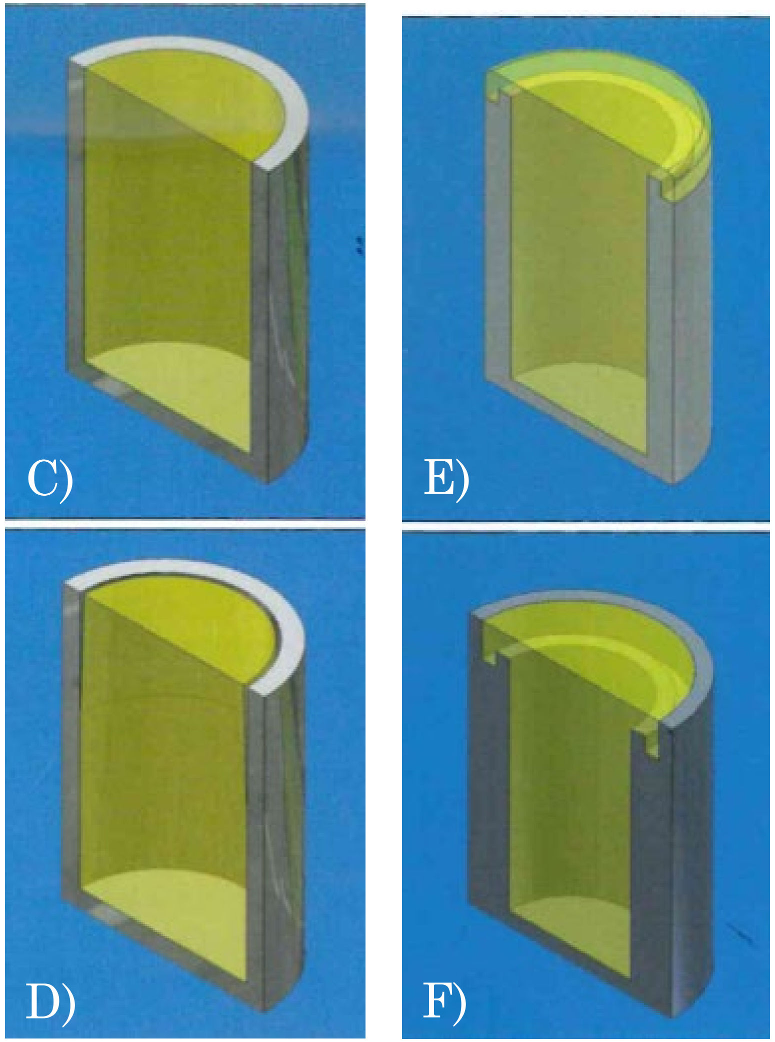
Coefficient of Thermal Expansion

- CTE = (ΔL/L0) / ΔT



Design Considerations





- Sharpe edges
- Draft angles
- Part thickness
- Skylining

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Design Considerations Cont.

- Tolerance
  - Shrinkage of LPM
  - Insert tolerance
- Color
- Pad printing/laser printing
- Air vent
  - Different from traditional injection molding
  - Inserts
  - Sharp edges
- Runner location
- # cavities

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Common Test on Adhesives

- Lap shear
- Peel test
- Tape test
- Tensile test
- Thermal cycle test
- Others…

Future of LPM

- Specialized materials for different need
- Filler additives and reactive technologies
- Typically need specialized equipment for dispensing but still in low pressure regime

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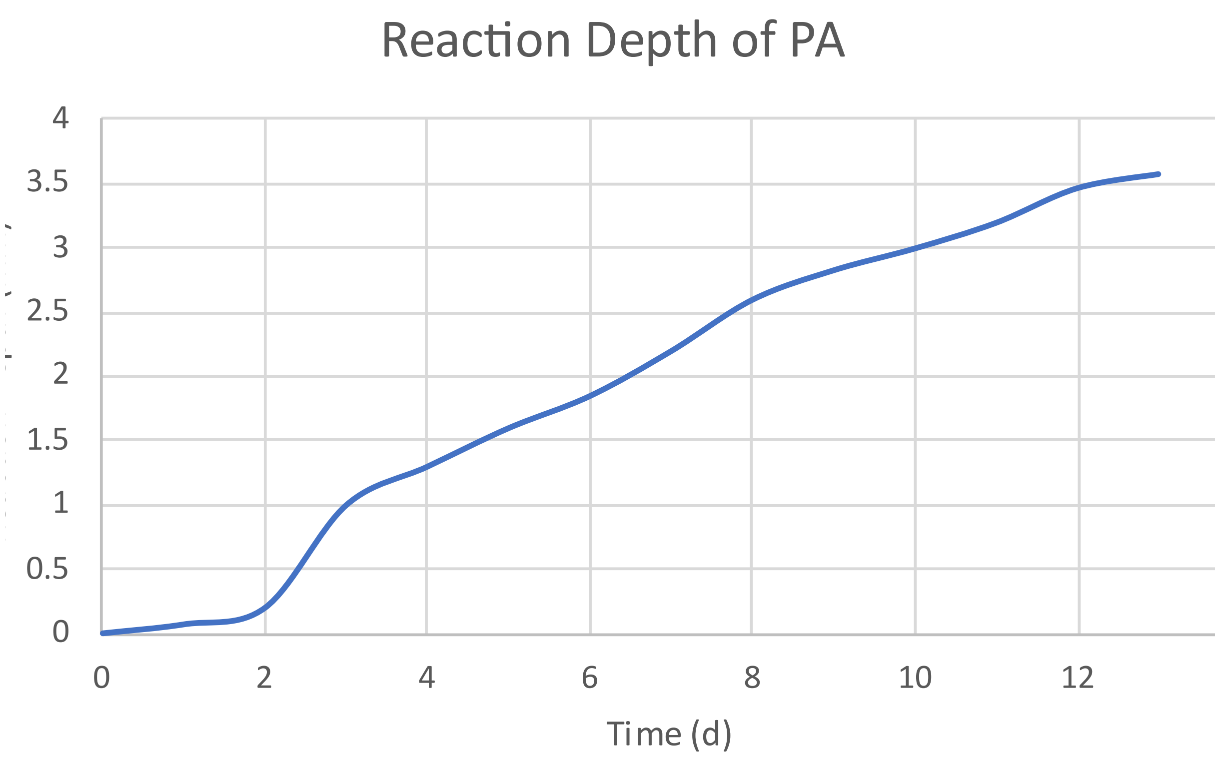
Thermally Conductive

- High temperature resistivity
  - Stable to 200 °C
- Moisture reactive
- Delayed to full strength

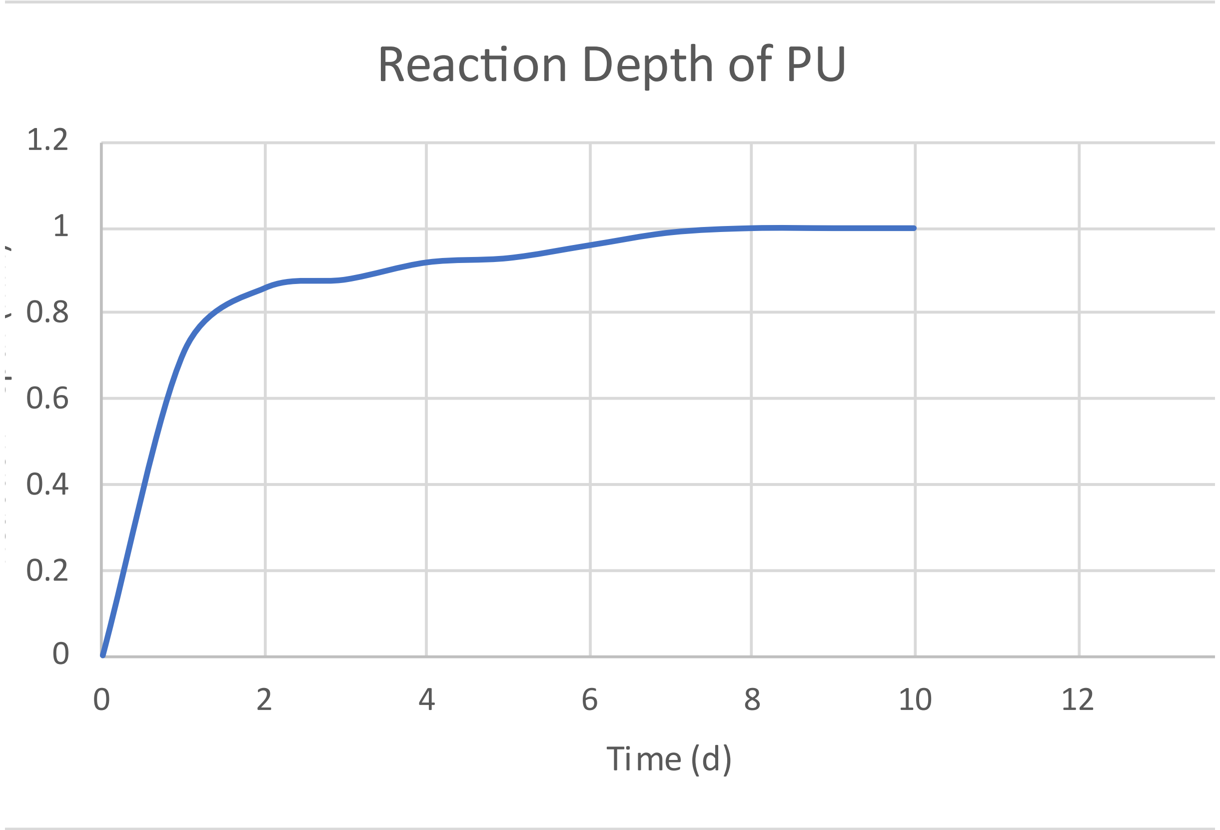
Post-crosslinking PA

- High temperature resistivity
  - Stable to 200 °C
- Moisture reactive
- Delayed to full strength



Post-crosslinking PU

- Low temperature usage
- Moisture reactive
- Delayed to full strength
- Stable to 80°C



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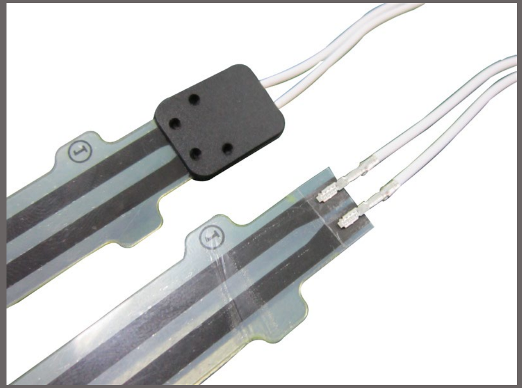
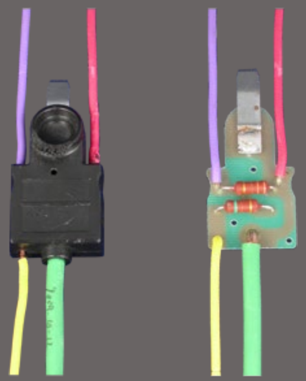
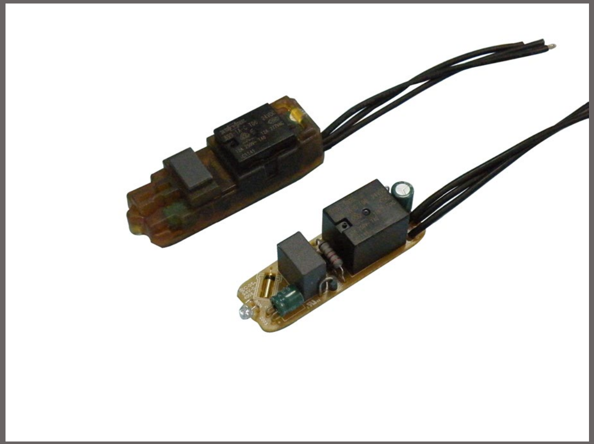
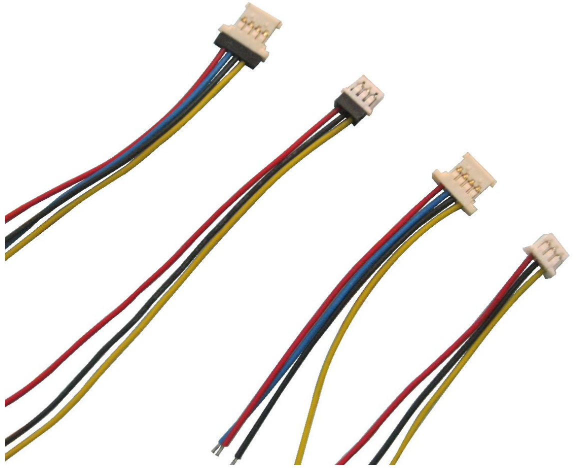
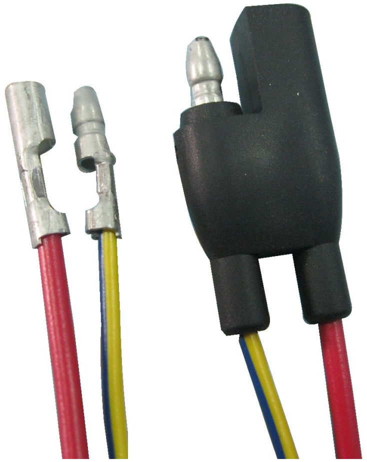


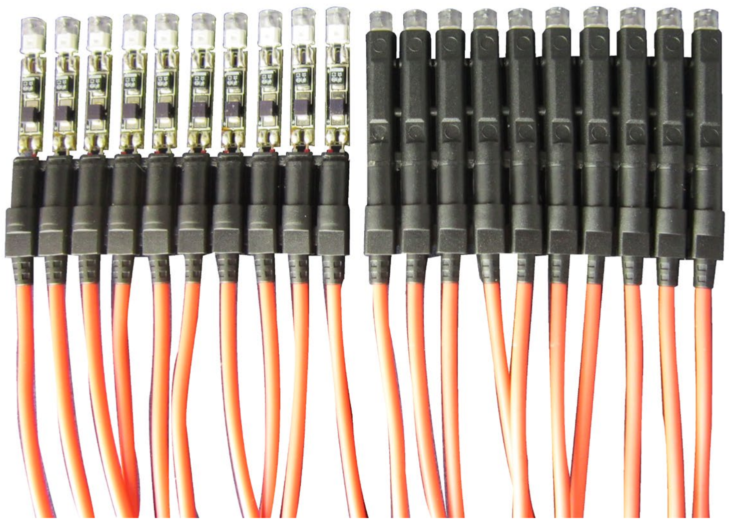


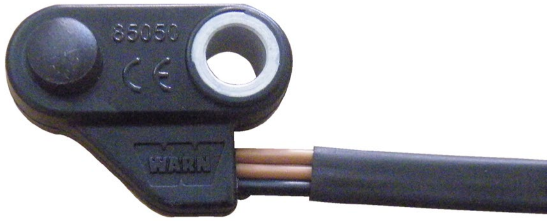


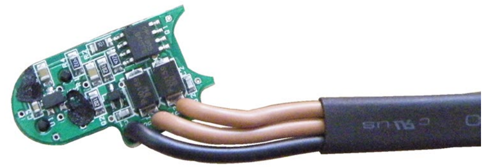
Overmolding Pictures

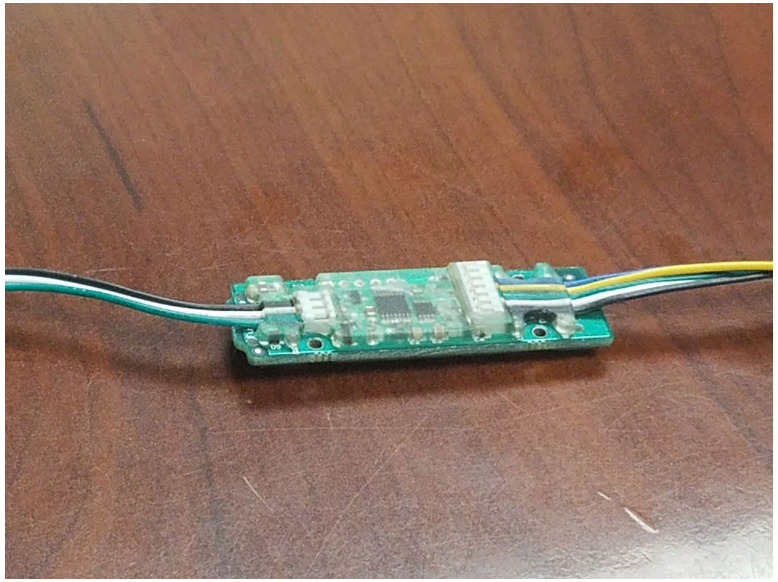


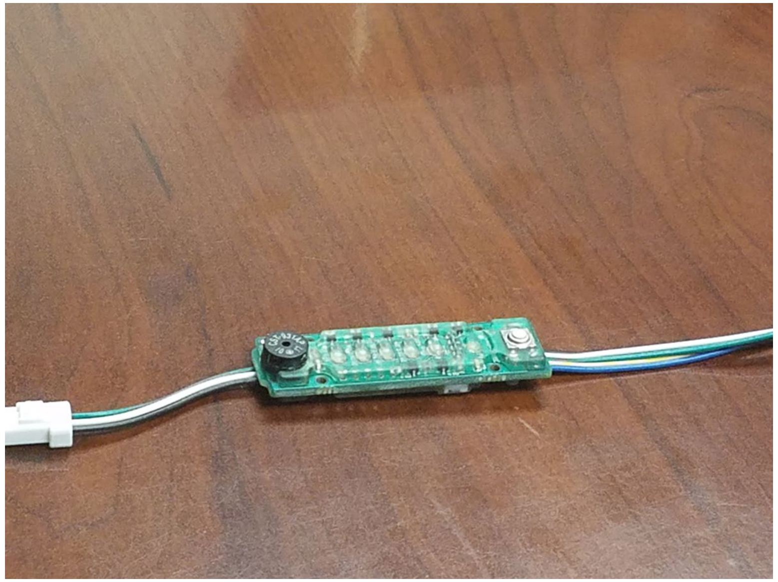




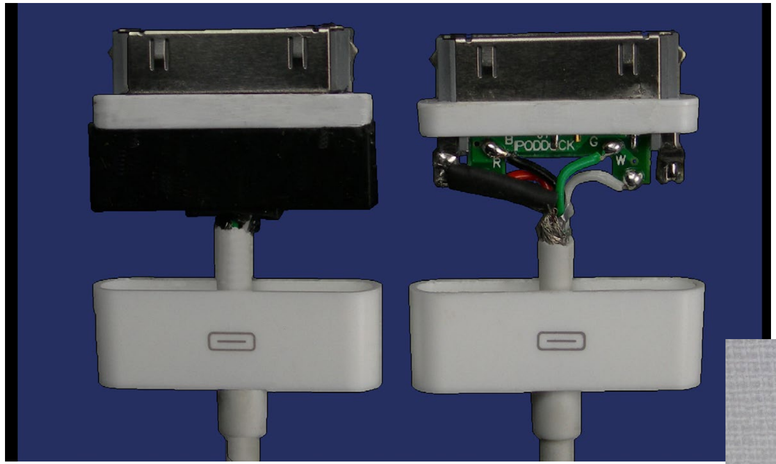


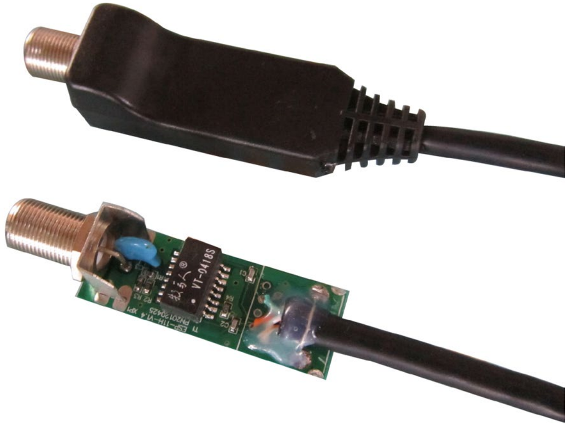




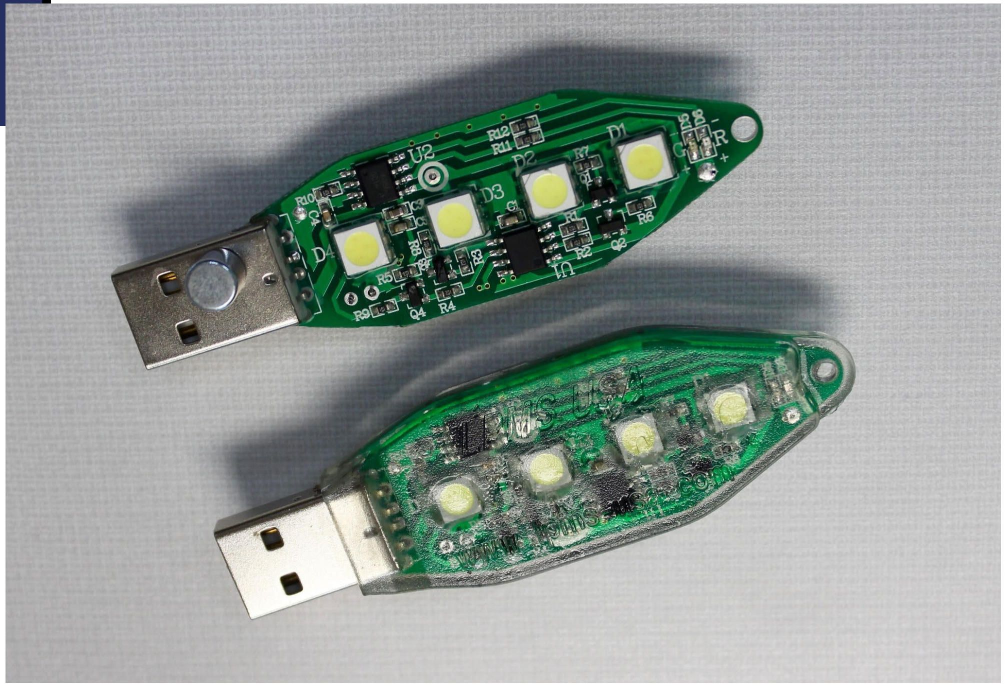


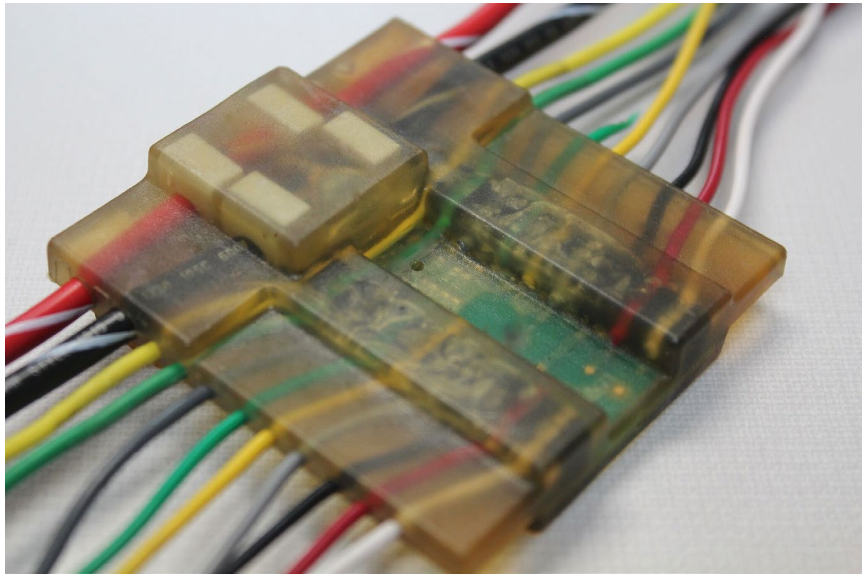

MASSAGE
HEAT

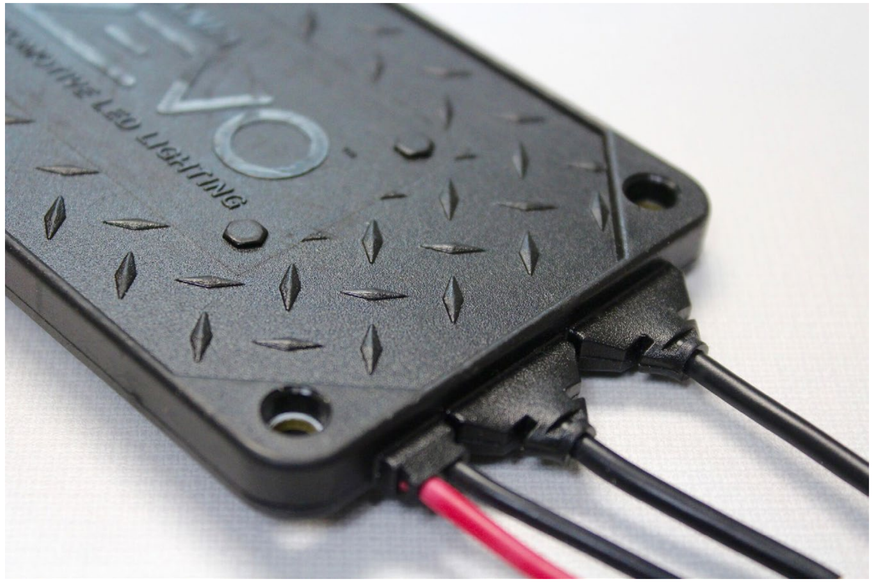

PODDUCK



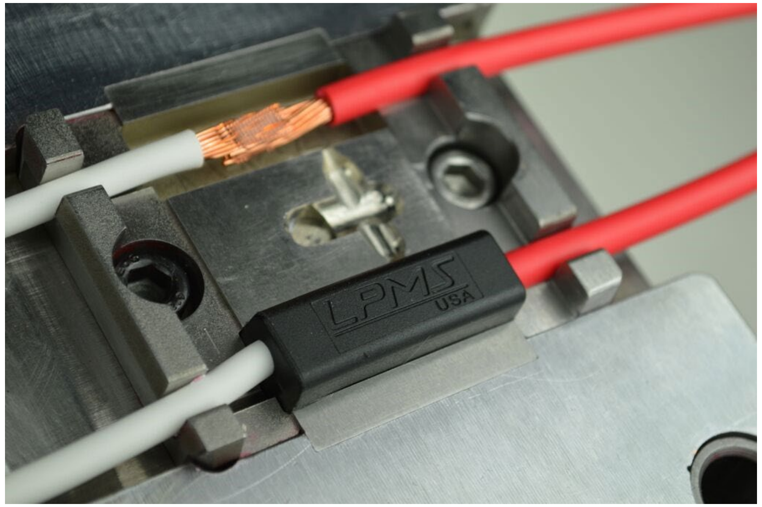

Henkel



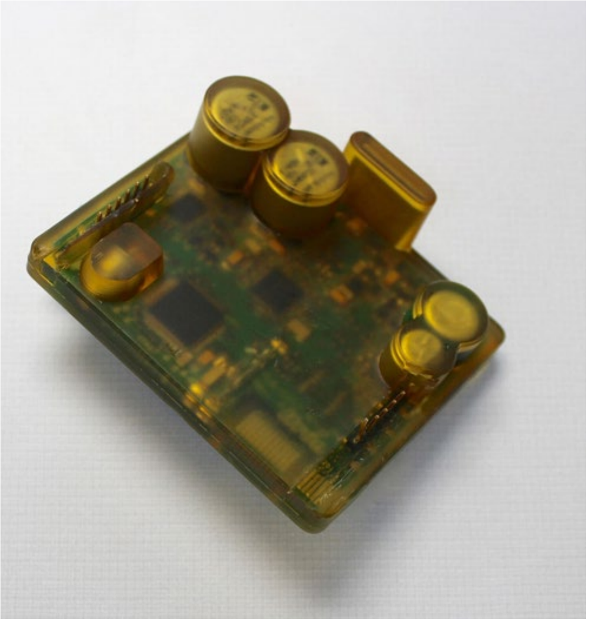


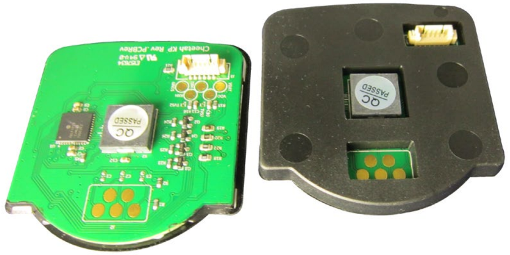


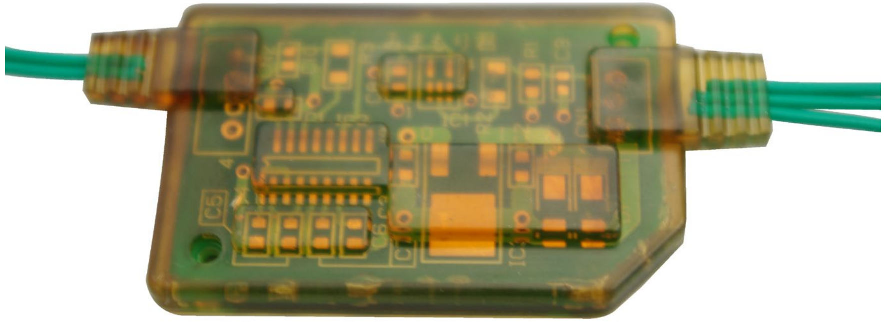
EVO
LED LIGHTING

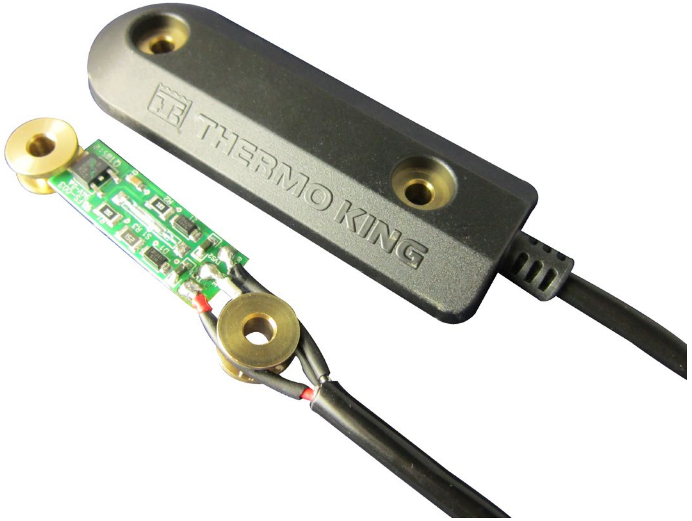


LPMS
USA








THERMO KING