PPG Solutions for Mobility

We protect and beautify the world
PPG: More than 47,000 employees protecting and beautifying our world

A global maker of paints, coatings, and specialty materials

A leader in all our markets: construction, consumer products, industrial and transportation markets and aftermarkets

Headquartered in Pittsburgh, Pennsylvania, with operations in more than 70 countries

Founded in 1883

Fortune 500: Ranked 205
Two product segments drive our $15.4B business

Performance Coatings: 59%
- Aerospace
- Architectural Coatings
- Automotive Refinish Coatings
- Protective and Marine Coatings

Industrial Coatings: 41%
- Automotive OEM Coatings
- Industrial Coatings
- Packaging Coatings
- Specialty Coatings and Materials
Innovation by the Numbers

- **> 3% sales ~ $500 million**: annual R&D Investment
- **3500+**: technical employees at more than 100 locations
- **32%**: of sales from sustainable products, 60% increase since 2012
- **40% of Sales**: 2025 target for total sales from products or processes that improve sustainability
Coatings Enable Protection & Beautification + E-Mobility

First Layers
- Pretreatment
- Electrocoat
- Primer
- Basecoat
- Clearcoat

Specialized Autonomous Driving Equipment
- Light detection and ranging active
- Easy-clean sensors
- Radar compatible

Decorative Automotive Parts and Accessories
- Bumpers
- Mirror Housings
- Handles
- Trim

Automotive Parts And Accessories
- Wiper arms
- Running boards
- Bumpers
- Tow hitches
- Roof racks

Existing Content is Changing

Suspension
- Coil springs
- Shock absorbers
- Control arms

Interiors
- Instrument panels
- Interior panels/trim
- Entertainment consoles
- Interior displays
- Durability, cleanability

EV Battery
- Battery Cell
- Adhesives and Sealants
- Dielectric
- NVH
- Fire Protection

Functional Coatings For Sensors and Antennas
- Antiglare lenses
- Easy-to-clean lenses
- Conductive inks
- Passenger classification
- Flexible heating
- Control panels
- Self-dimming mirrors
- Radio frequency interface shielding

PPG Confidential Information
3 Examples of PPG Coatings Enabling Sensor Performance

LiDAR wavelengths

Radar wavelengths

Obstructed lens & housing

Colors naturally absorb/reflect

Nature always a factor

PPG Coatings Improve “Visibility” Of Dark Colors

PPG Coating Minimize 2-way Signal Loss

Coatings keep interfaces clean, Allow reliable sensor signal transfer
Common functional challenges we address….

- Glare mitigation
- Stain resistance
- Haptic effects
- EMI shielding
- Capacitive control
- Shock mitigation
- Scratch resistance
- Electrical conductivity
- Wear resistance
- Chemical resistance
- Exterior durability
- Bonding
- Sealing
- Joining
- Solar thermal management
- Thermal insulation
- Passive fire protection
- Dirt mitigation
- Fire retardancy
- Resistive heating
- Impact protection
- Reflection mitigation
- Fouling mitigation
- Fingerprint mitigation
- Vibration control
- Friction management
- Noise control
- Corrosion protection
- Electromagnetic radiation management (UV ⇒ microwave)
- Thermal conductivity
- Thermal insulation
- Dielectric protection
- Sealing
- Passivation

… can impact battery pack design, safety & performance
Solutions for Li Ion Batteries

- Solutions for the electrodes
  1. NMP free cathode binder
  2. Graphene systems

- Solutions for the pack assembly
  1. Corrosion and impact
  2. EMI/RFI shielding
  3. Bonding and sealing
  4. Dielectric isolation
  5. Fire protection
  6. Thermal conductivity

PPG coatings and materials can solve major challenges – solutions enabling performance, durability, safety, and cost
Lithium Ion Battery Cells – PPG’s Electrode Binder Solution Delivers Value Benefits for Change

Safety, Cost, Performance

Formulation Safety, Global Compliance
- Solventborne NMP Free

Electrode Manufacturing Costs
- Higher Solids
- More Cells per Batch
- Less Solvent
- Recovery Shorter Mix Times
- Longer Pot-life

Battery Cell Design Flexibility
- Power & Energy Density
- Thicker, Flexible Film Builds
- Lower Impedance

Battery Cell Performance
- Uniform Binder Distribution
- Better Cycle Life
Corrosion: Leveraging a legacy to protect the battery assembly

Proven approaches for the harshest body & underbody applications adapted for various EV design scenarios

We protect and beautify the world™
Dielectric materials used throughout the pack assembly

Essential for safe operation:
- Electrically insulating
- Stable to high voltage electrical fields
- Isolate high-voltage electrical components from one another and from people

Used to isolate:
- Many components within the assembly
- 3D and complex shapes
- Different and specialized requirements

Industry formerly using film, tape & sleeves which have emerging challenges
1K Solution
- Density: 1.45
- Automated application (Temp 90 -100°C)
- Minimum time between bead application and lid assembly: 1mins at RT
- Hardness: 15 Shore A
- Service-able
- 12 month shelf life

2K PU Foaming Solution
- Density: 0.4 – 0.5
- Viscosity:
  - Part A: 25,000 – 35,000 mpa.s
  - Part B: 200 mpa.s
- Mixing Ratio: 100/22
- Minimum time between bead application and lid assembly: 20mins at RT
- Automated application with dynamic mixing head
- Shore Hardness: 70 shore 00
Case study 1: 2K CORATHERM

- Standard attributes
  - Thermal conductivity
  - Thermal cycle stability
  - Automated dispense capable
  - Reach Compliant

- Design specific key attributes
  - Thin bond line
  - Low thermal impedance
  - Removability for ease of service
  - Hybrid resin systems
  - 1:1 mix ratio

Case study 2: 1K CORATHERM

- Standard attributes
  - Thermal conductivity
  - Thermal cycle stability
  - Simple dispensing process
  - Reach compliant

- Design specific key attributes
  - Low abrasiveness
  - Removability for ease of service
  - Electrical isolation
  - No creep over use lifetime
  - Flat ribbon application

Customized solutions for productivity, performance and applied cost advantages
PPG Battery Fire Protection (BFP)
Technologies under qualification for high nickel active thermal events

- Leveraging proven intumescent technologies
- Very strong char after 1200 °C flame test
- Able to withstand >2000 °C for 4-5 minutes

<table>
<thead>
<tr>
<th>Property</th>
<th>Performance</th>
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</thead>
<tbody>
<tr>
<td>Number of components</td>
<td>2</td>
</tr>
<tr>
<td>Color</td>
<td>White</td>
</tr>
<tr>
<td>Gloss</td>
<td>Semi-gloss</td>
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<tr>
<td>Applied Density</td>
<td>1.2 – 1.4 kg/L</td>
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<tr>
<td>Volume Solids</td>
<td>100%</td>
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<tr>
<td>VOC</td>
<td>0 g/L</td>
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<tr>
<td>Theoretical Spread Rate</td>
<td>2.0 m²/L for 500 µm</td>
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<tr>
<td>Expansion After Fire</td>
<td>10 – 40 times</td>
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</tbody>
</table>

**Application Data**

- Recommended Film Thickness: 200 – 1,500 µm
- Dry to handle: 24 hours at 23° C (20 minutes at 120° C)
- Shelf Life (When Stored Cool & Dry): 6 months: base and hardener

Applying experience with jet fire mitigation to tailor solutions for highly energetic actives and high velocity cell rupture blasts.
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