Coatings Trends & Technologies SUMMIT

Who Needs Liquid Paint? Reinventing Surface Protection

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ChemQuest

actionable insights for success

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- Introduction to ChemQuest
- Understanding Paint Protection Films (PPFs)
- Transportation Market
- Built Environment
- Energy Market
- Learning from Film Technology and Further Development

The ChemQuest Advantage:
Insight to navigate the intersection of strategy, markets, operations, and technology

Strategic Thought Partners

Delivering distinctive, thorough, actionable, confidential, and professional work to support our clients in every aspect of sustained, profitable growth, including:

- **Business Strategy & Transformation**
- **Technology Development**
- **Operational & Manufacturing Efficiencies**
- **M&A Advisory Services**

100% of our work is proprietary, offering a full portfolio of services under NDA

Extensive Industry **Relationships** and **Knowledge**

Stakeholders across the value chain trust our thought leaders:

- Team is more than 130 minds strong, including ~ 48 Ph.D. chemists.
- Senior personnel each have a minimum of 25 years of experience in specialty chemicals and materials.
- Extensive roster includes former senior managers from major manufacturers, business owners, and senior technical managers.

Our Mission is **Enabling Our Clients to:**

- Build enterprises that challenge established thinking and drive transformation.
- Gain competitive advantage through distinctive, targeted, and substantial improvements that sustain profitable growth.
- Unlock new and hidden insights, empowering an organization's smart risk-taking, catalyzing innovation excellence and value creation.
- Be successful — because our success emanates from yours.

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Paint Protection Films (PPFs)

Early History of PPF Development

Origins in Military Applications

Development by 3M

- The origins of PPF can be traced back to the Vietnam War, when the U.S. military, in collaboration with 3M, developed a film to protect helicopter rotor blades from debris and shrapnel damage. This initial version was much thicker and more rigid than today's films.
- In 1966, 3M created window film technology that added metallic coatings to clear polyester for a flexible film that blocked most of the sun's harmful heat and UV rays.

Commercial Availability

Consumer Market Expansion

By the mid-1990s, PPF became more widely available to the public. Early versions were used to protect the leading edges of cars, such as hoods, bumpers, and side mirrors. However, these films were still relatively thick and not as visually appealing as today's versions.

Transition to Automotive Use

Introduction to the Automotive Market

In the late 1980s and early 1990s, 3M began to adapt this protective film for automotive use. Initially, it was used primarily in racing and high-performance vehicles to protect the front end from damage during races.

Enhanced Performance and Aesthetics

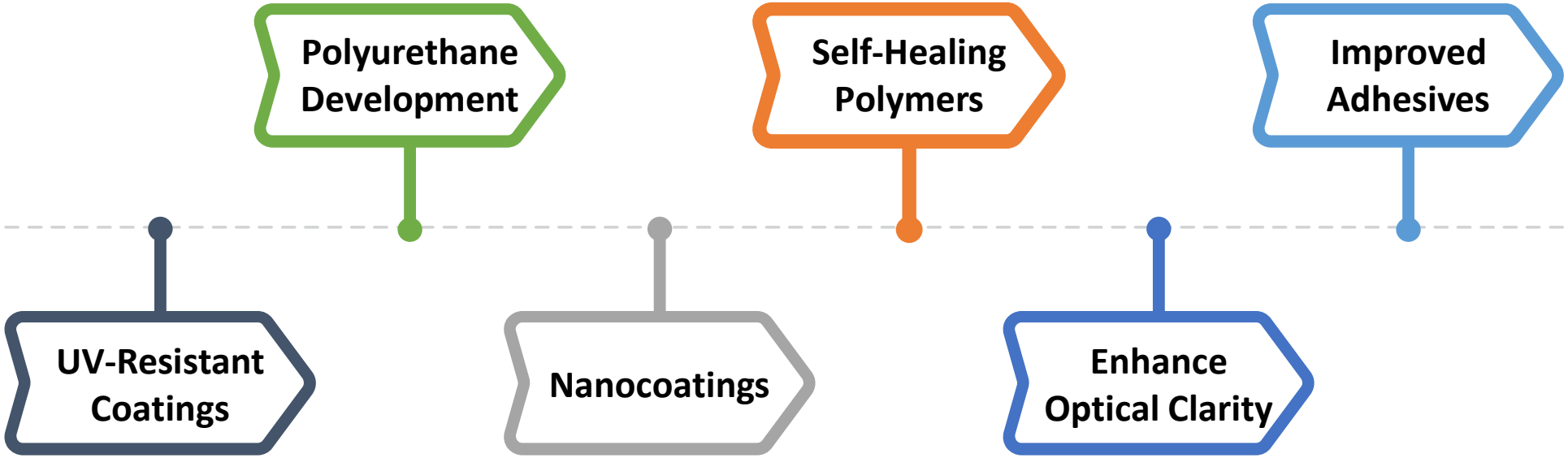
- **Improved Adhesives and Topcoats:** During this decade, manufacturers improved the adhesives used in PPF, making installation easier and reducing the risk of bubbles and peeling. Enhanced topcoats also provided better gloss and resistance to yellowing and staining.
- **Computer-Cut Patterns:** The advent of computer-aided design (CAD) allowed for the creation of precise patterns for different vehicle makes and models. This innovation reduced installation time and improved the overall fit and finish of the film.

Advancements in PPF Technology

- Polyurethane has superior elasticity, resistance to abrasion, and clarity.
- This advancement improved the film's ability to conform to complex vehicle shapes and provided better protection without compromising aesthetics.

- Self-healing polymers allow for repair minor surface damage when exposed to heat, maintaining the film's appearance and functionality over time.
- This development has significantly increased the longevity and appeal of PPF for consumers.

- Advances in adhesive technology have made PPF easier to install and remove without damaging the vehicle's paint.
- Modern adhesives offer strong bonding properties that ensure the film stays in place under various conditions while allowing for clean removal if needed.

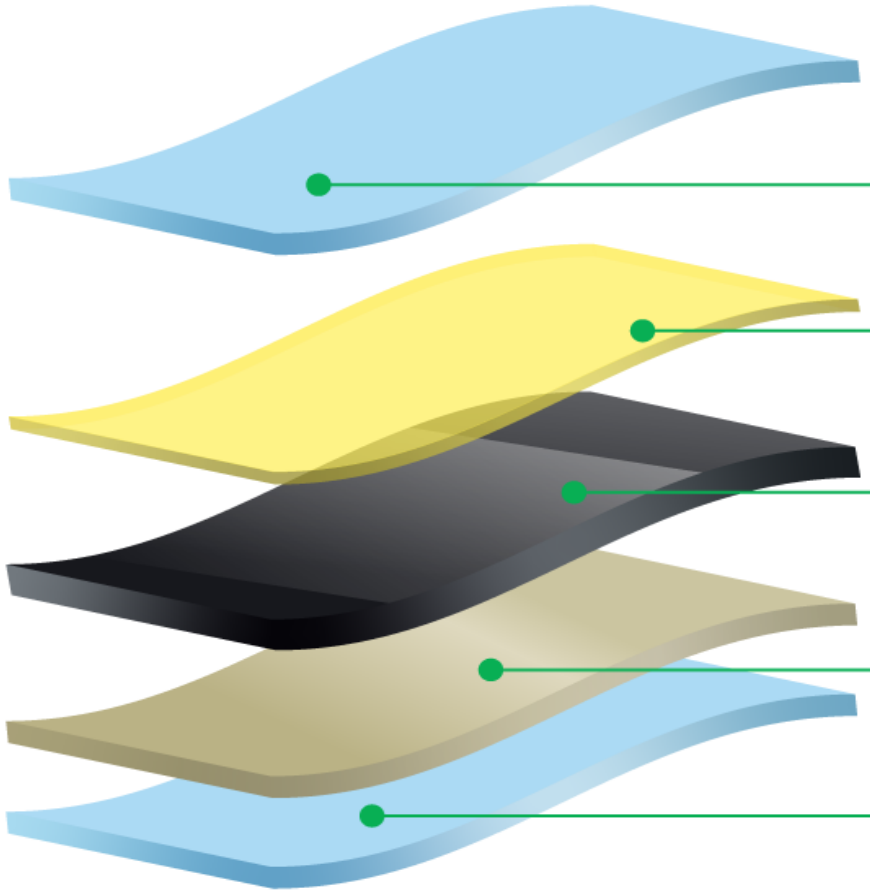


- UV-resistant coatings enhanced the ability to protect against sun damage.
- These coatings prevent the film from yellowing and degrading over time.

- Nanotechnology has led to the development of films with superior hydrophobic properties.
- These nanocoatings repel water, dirt, and other contaminants, making the film easier to clean and maintain.

Improvements in manufacturing have led to films with better optical clarity, ensuring that PPF is virtually invisible once applied.

PPF Typical Film Structure



Protective Cap Sheet
To protect film during transportation

Self Healing top coat
This layer provides superior shine and protection

Aliphatic Urethane film
Durable, soft and high impact resilient layer

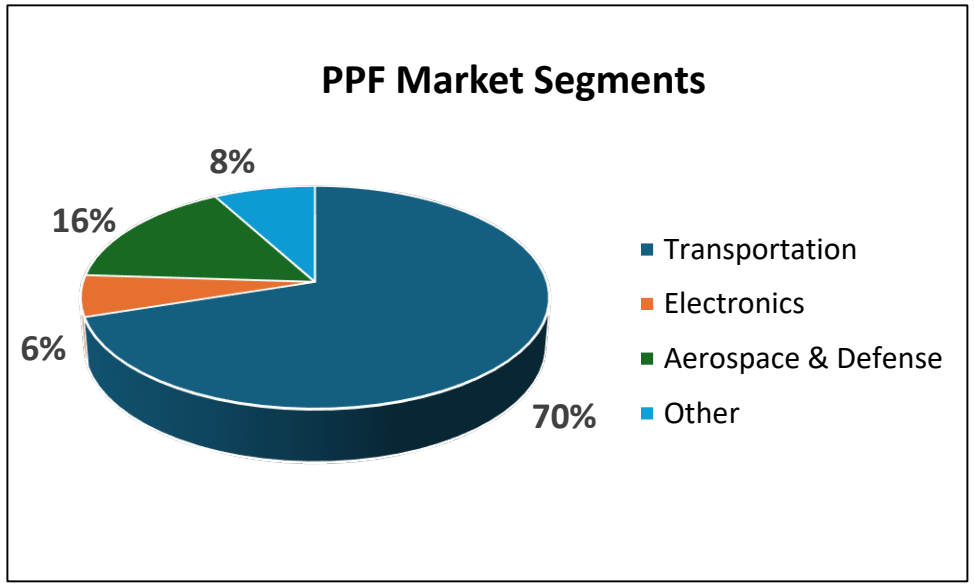
Acrylic Adhesive
Crystal clear adhesive system

Strong Polyethlene liner
Helps to allow computer cutting on plotter

Source: afgearservices.com

PPF Global Market

- **2023 Mkt:** $700 M
- **Projected 2033 Mkt:** $1.3BN
- **2023-2033 CAGR: 7%**



Film Types

- Aliphatic thermoplastic polyurethane (TPU): 85%
- Polyvinyl chloride (PVC) (1st-gen films): 10%
- Others (e.g., polyester, polypropylene): 5%

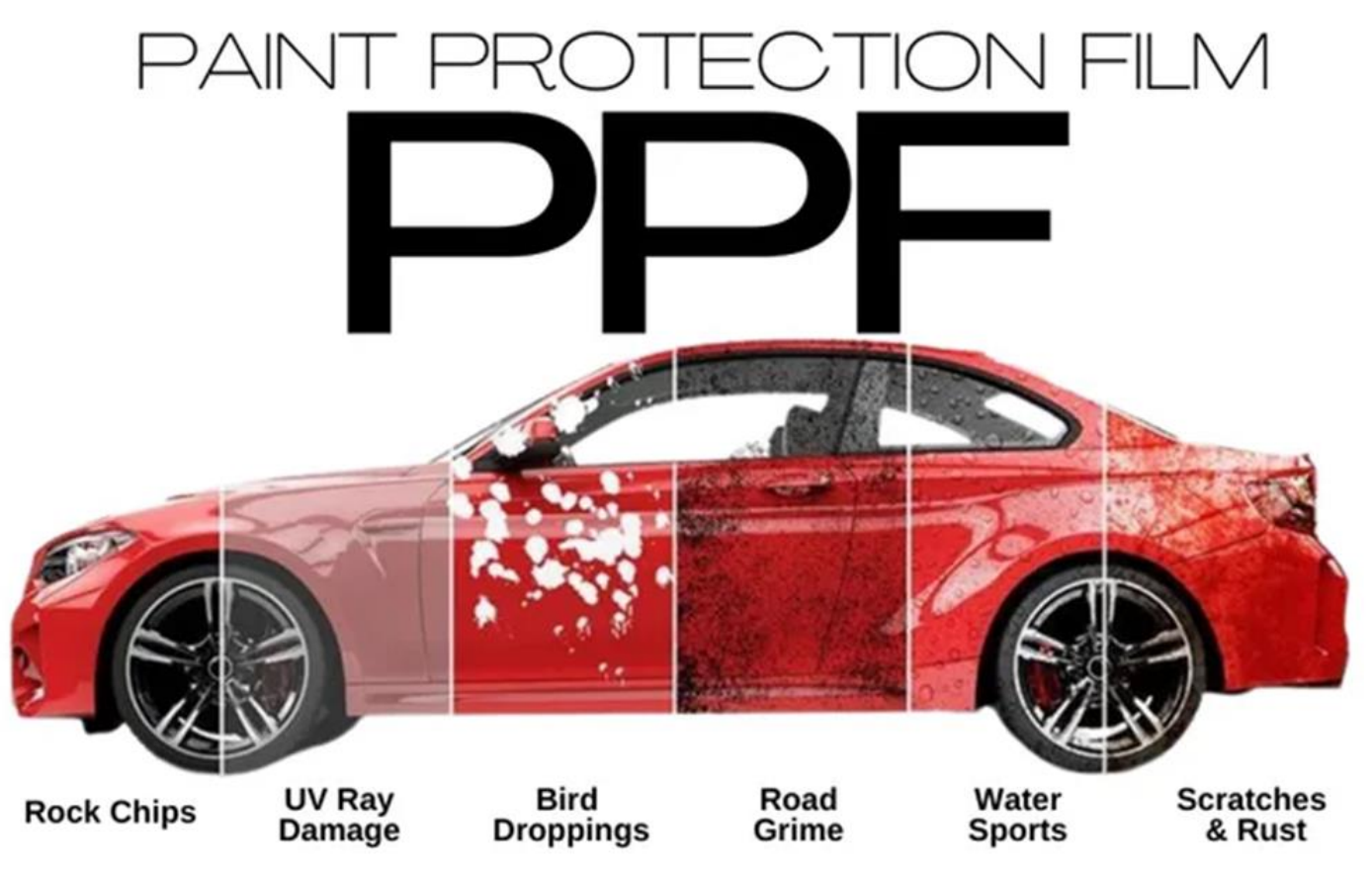
Major North American Competitors

3M Science. Applied to Life.™
XPEL PROTECTIVE FILMS
AVERY DENNISON
CoreTech PERFORMANCE FILM SOLUTIONS
RENOLIT
EASTMAN Performance Films, LLC
+
PremiumShield
HEXIS
ORAFOL
SAINT-GOBAIN

Source: Grand View Research, company websites, news.ppg.com

Transportation Market

Auto & Truck



Automobile & Trucking

PPFs have become a popular alternative to paint for auto manufacturers and vehicle owners.

- **Cost**

  A paint job can cost between $3,000 and >$10,000, while a PPF can cost between $2,500 and $5,000. PPFs can also be more cost-effective in the long run because they require less maintenance than paint jobs.

  OEM factory-applied liquid paint requires costly energy for drying, and OEMs are considering moving to PPF.

- **Design options**

  PPFs offer more design and finish options than paint, including solid colors, color schemes, matte finishes, and mirror finishes. They can also be used to duplicate a stock color or create a color that the factory doesn't offer.

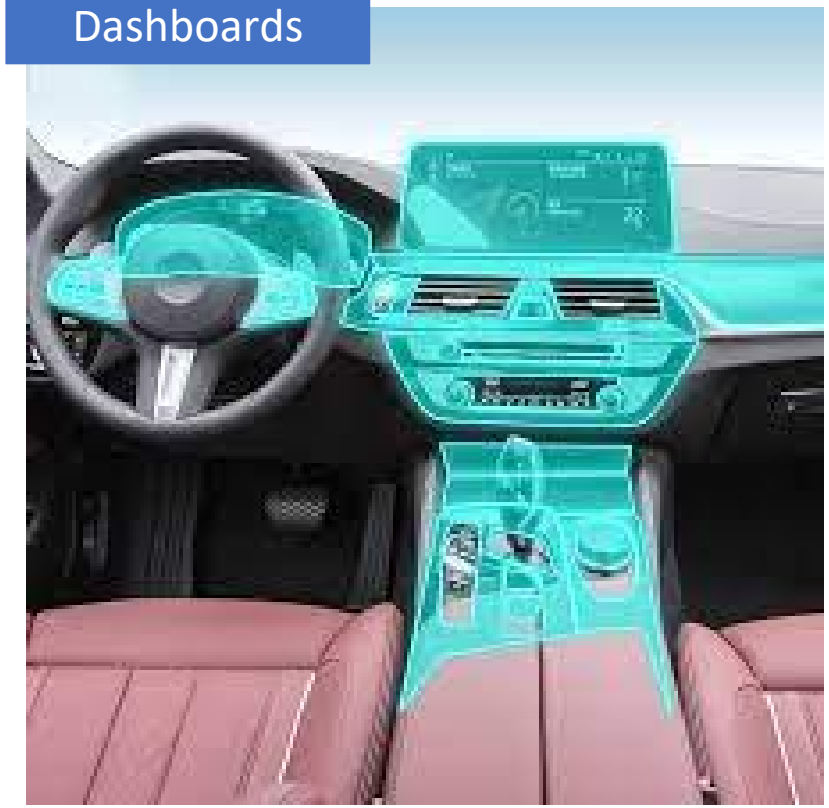
- **Maintenance**

  Wraps are easier and less expensive to maintain than paint jobs. Wraps can also protect the original paint from wear and tear; with proper care, a high-quality wrap can last up to seven years or more.

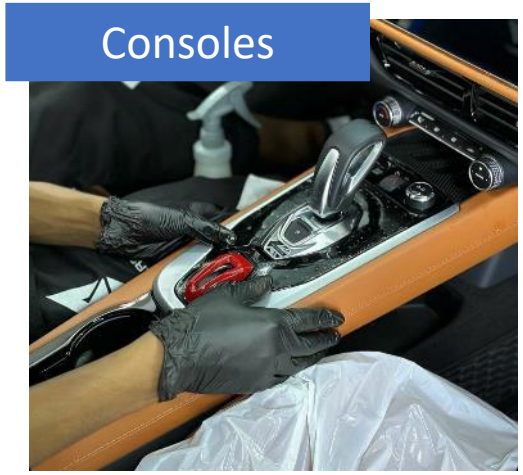
Source: jdpower.com How Much Does It Cost to Paint a Car?

Auto Interior PPF Film Examples

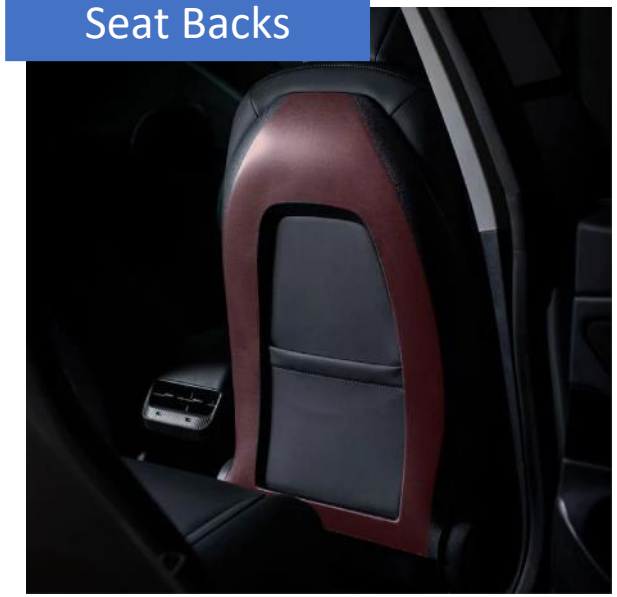
Dashboards



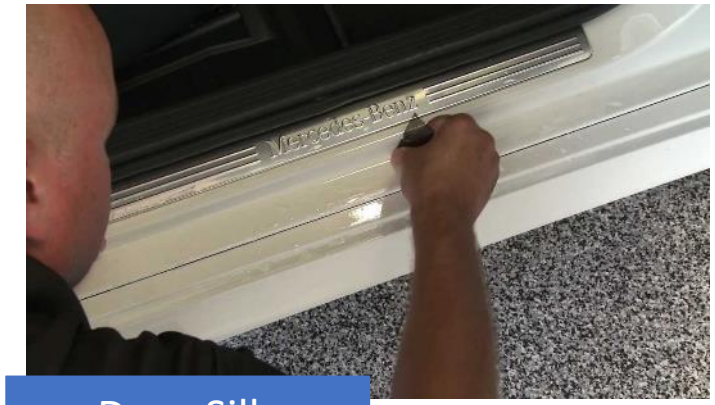
Consoles



Seat Backs



Door Sills



Source: xpel.com, sunprotectivefilms.com

PPF for Recreational Vehicles

Benefits of PPF

- Boosts resale value
- Customization
- Better durability
- Cost less than painting
- Less environmental impact
- Quick installation
- Easy to clean

Source: 3m.com, averydennison.com

Built Environment

Interior Surfaces & Furniture

Films for use on furniture, doors, walls, and ceilings — on wood/wood composites, metal, drywall

- Scratch and abrasion resistant
- Chemical resistant
- Waterproof and vapor resistant
- Mold resistant
- Light-fast
- Easy to clean
- Free of formaldehyde and plasticizers
- Variety of designs and embossing
- Offers soft-touch and fingerprint-free surfaces

Source: sunvase.com, rvinyl.com

Roofing

Films designed to exhibit passive radiant cooling

- Materials absorb more solar energy during the day than they can radiate to the sky. At night, the surrounding environment cools the material to a temperature that is below the dew point.
- 3M's Passive Radiative Cooling Film (PRCF) reflects enough solar energy to allow passive radiative cooling to occur during the day.
- Developed using butterfly biomimetic model
- Control the refractive index by having alternating layers of birefringent polymers and isotopic polymers (PEN-PMMA)
- Tunable
- 99% reflective
- Funded as an ARPA-E project in conjunction with Lawrence Berkley National Labs ($2.77 M)

  These cooling films are aimed at reducing electricity consumption for air conditioning, refrigeration systems, transportation, and data centers.

Source: 3m.com

Anti-graffiti Film

Films designed to protect surfaces against damage from vandalism, graffiti, etching, scratches, or abrasion

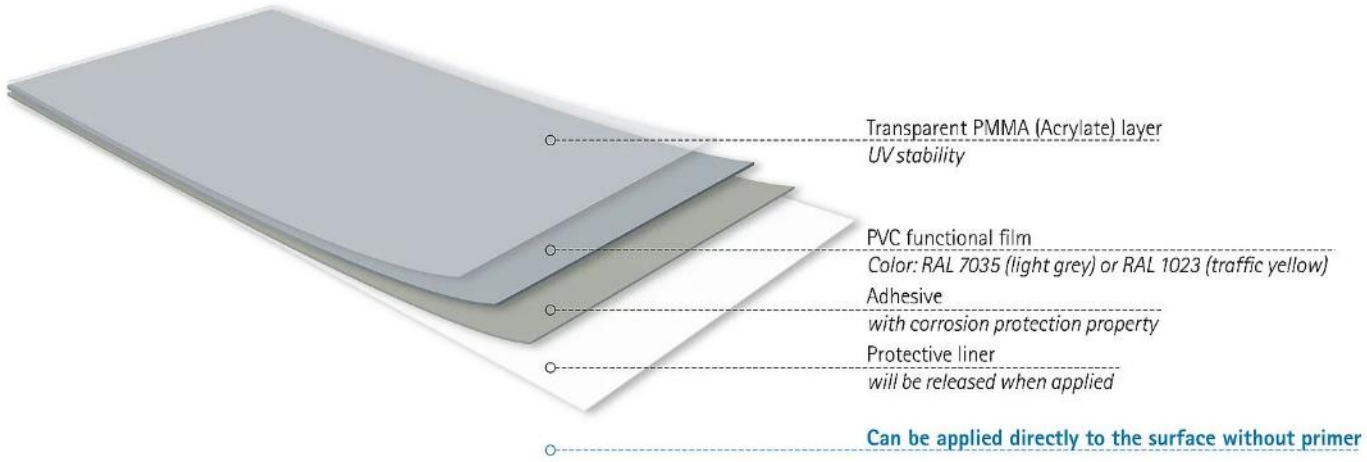
Serve as a sacrificial (removable) layer to protect glass from scratches, abrasion, and acid etching

Source: 3m.com, solarart.com

Energy Market

Wind Turbines

- PPF offers corrosion protection for onshore and offshore wind turbines.
- Minimizes downtime and out-of-service time: application without primer or drying phases
- Environmentally friendly and sustainable: no hazardous substances or VOC emissions
- Certified in accordance with the BAW standard and ISO 12944-9 CX (protection duration: high)
- Offers long-term corrosion protection of 10 years and more
- Saves 60% in material costs as a one-layer system
- Quick and easy to apply
- Reduces need for extensive surface treatment work and drying phases



Source: renolit.com

Refrigeration and Power

- Startup from Cornell University called Heat Inverse LLC
- Films designed to exhibit passive radiant cooling
- Uses selective photonic emitters that allow certain wavelengths of light to be emitted above the atmosphere, enabling passive cooling of more than 12.5°C (100 W/m^2), with zero energy input and no waste heat generation
- Passive cooling is inherent in the microstructure of the film, providing seamless cooling capabilities.
- They call it the *Reverse-Greenhouse Effect* because heat is transferred back to the atmosphere.

Pilot Project Examples

Refrigerated Trucking Industry

Energy Systems Projects
(BESS, Inverters, Transformers)

Source: heatinverse.com

Learning from Film Technology and Further Development

Why Films Can Replace Paint

Films have superior durability, sustainability, and low maintenance.

- Exterior films can last 7-10 years.
- Offered in many colors, metallics, patterns, sheens, and graphic designs
- Conformability to complex shapes
- Waterproof (hydrophobic)
- Easier to clean than paint
- Resistant to extreme heat conditions
- Abrasion and impact resistance
- Fade resistant – less oxidation
- Self-healing qualities
- High optical clarity
- Easy to manufacture by extrusion and roll-to-roll processes

  Requires less energy than making liquid paint
- Smaller carbon footprint

What Films and Paints Share

- Surface preparation is key
- Application is labor intensive
- Application requires skill

PPG Advanced Surface Technologies (AST)

- In 2021, PPG purchased Wörwag, a Germany-based manufacturer of paint films.
  - Produce the coating as web material
  - Wind it up as a roll
  - Paint film roll is cut or plotted for individualization purposes.
  - There is **no overspray or drying time, and it's ready for immediate use.**
- PPG formed AST in May 2023 as a joint venture with entrotech, Inc. and Aero Sustainable Material Technology

Land Rover Defender

Source: ppg.com, aerotechnology.com

PPG Advanced Surface Technologies (AST)

AST offers paint and clear film solutions for the automotive, body shop, and general industrial markets.

- Contains zero PVC, zero solvents, and is virtually VOC free. In application, it uses zero water and emits zero carbon. It requires no primer, overspray, or clear coat.
- 100% recyclable. Its favorable environmental footprint also requires less regulation, which reduces associated costs of compliance, including abatement and reporting costs.
- Thickness = 50 microns in its final form. Because graphics are embedded within AERO paint film, there's less drag. Less drag translates into fuel savings for any business that puts a fleet of vehicles on the road every morning.
- Weighs less than a one-coat system, resulting in cost savings by reducing fuel usage
- Ability to embed electronics for advanced civilian and military wireless applications, allowing for unlimited flexibility with a single adhesive product for installation purposes

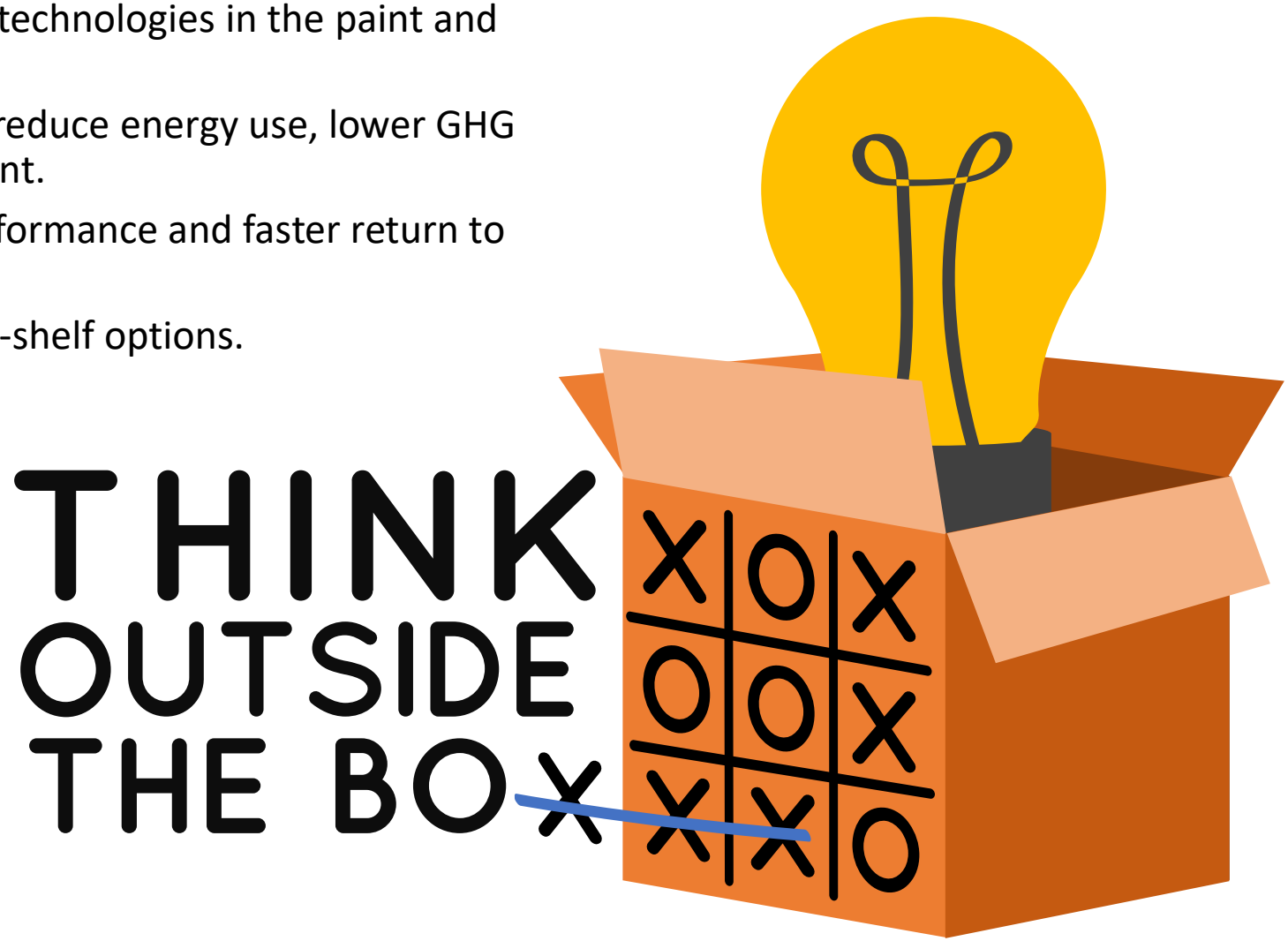
Boeing Dreamliner 787

Source: ppg.com, aerotechnology.com

Final Thoughts

- Sustainability is driving development of new technologies in the paint and coatings industry.
- The industry is facing regulatory pressure to reduce energy use, lower GHG emissions, and reduce environmental footprint.
- Users of paints and coatings want higher performance and faster return to service.
- Consumers prefer customization over off-the-shelf options.

- **Paint performance films represent an out-of-the-box solution that addresses many of these issues directly.**
- **Paint companies can embrace collaborative partnerships with existing film companies to expand their portfolio and create new business models.**



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Thank You!
Questions? Comments?
Please reach out:

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Deep Industry Knowledge – Extensive Industry Relationships – Decades of Industry Experience

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