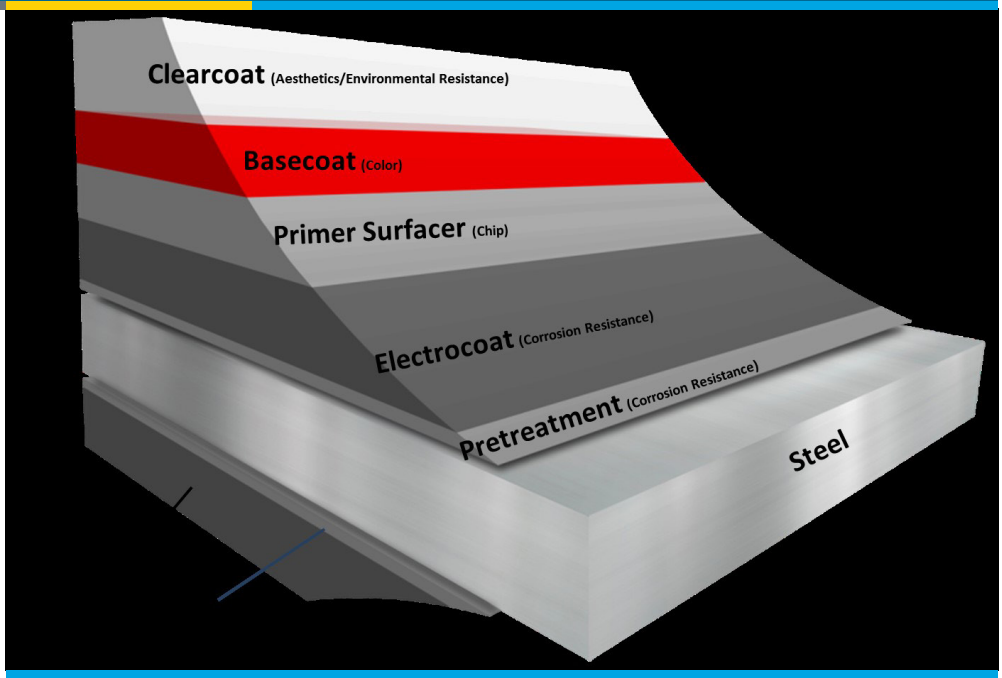
Coatings and Process Development for Reduced Energy Automotive OEM Manufacturing

Enabling low-temperature curing and novel processes for application of clearcoat, basecoat, and primer layers at automotive paint shops

Few durable goods have the impressive appearance of today's automobiles. But, there is a cost for that finish. The paint shop in automotive assembly plants typically accounts for more than two-thirds of energy consumed at the plant. Of that energy, three-quarters supplies the paint spray booths and paint curing ovens. Coatings used by original equipment manufacturers (OEMs) require carefully controlled environments for both application and cure to meet quality and appearance standards. Coating applications require controlled booth environments to manage overspray and ensure a consistent coating. Paint curing ovens require elevated temperatures (285°F) and controlled airflow for even heat distribution, all of which contribute to the high energy intensity of the paint shop.

This project will combine new chemistries for coatings with new processes designed to take advantage of the novel coating's advanced properties. Each of the chemistries identified for evaluation will cure at temperatures well below typical coatings in use today. Furthermore, the chemical process by which the new coating technologies set and harden differs significantly from typical coatings, allowing new processes that require less air conditioning and smaller plant-floor footprints.



Schematic illustrating the layers of coatings from typical automotive manufacturing processes. This project addresses the outermost layers. *Graphic image courtesy of PPG*

Benefits for Our Industry and Our Nation

Reducing cure temperatures through novel coating chemistries and improving coating processes has the following benefits:

- Reduced energy consumption in curing ovens due to lower oven temperature requirements. Improved air flow will also reduce waste heat.
- Reduced time between layer applications can increase productivity for automobile manufacturers, and reduce the plant floor footprint.
- Lower conditioned air requirements reduces the energy consumed by HVAC systems. Similarly, reduced temperature and humidity control requirements allow for less energy consuming air-handling equipment.
- Compatible with temperature-sensitive materials such as polymers used in composites for vehicle lightweighting. Use of lightweight components will be a key contributor to meeting fuel efficiency standards.

Applications in Our Nation's Industry

This technology can provide the automotive manufacturing industry with a low-energy method of applying basecoat and clearcoat layers to automotive frames and other original equipment. The technology can be integrated seamlessly into the existing infrastructure, and even reduce the footprint of the paint shop in automotive plants. The chemistries developed will also be applicable to a wide range of industrial coatings operations such as appliance, aerospace, and heavy duty construction vehicles.

Project Description

The project objective is to demonstrate a lower energy/higher productivity automotive coating system with the potential to deliver a reduced manufacturing footprint but maintain quality, performance, and appearance. An initial screening of possible chemistries for low cure temperatures, appearance, and adhesion will lead to a limited set of candidates for further improvement. With characterization of the properties of candidate

formulations, researchers will refine the coating application and curing process, with emphasis on engineering solutions for air handling and booth design. The project team will investigate the potential to apply the basecoat/clearcoat layers in one "monobooth." Together, the novel materials and processes could dramatically reduce energy consumption in the paint shop of automotive assembly plants, while the monobooth concept could reduce the footprint of the paint shop on the assembly floor.

Barriers

- Establishing a polymer formulation that cures at sufficiently low temperatures in a sufficiently short time-frame.
- Testing a multitude of polymer formulations to narrow down to a limited set of chemistries for further refinement and process development.
- Producing a basecoat that maintains proper orientation of the metallic flakes embedded within.
- Ensuring the novel coatings are not too sensitive to variations in relative humidity in paint spray booths and curing ovens.

Pathways

Five different chemistries have been selected for preliminary evaluation as low-temperature coatings in automotive applications. The cure response will be evaluated at different temperatures, and the appearance and performance properties will be monitored using standard ASTM methods and manufacturer specific testing procedures. This process will allow researchers to down-select potential coating chemistries for further development.

In the next stage, focus will turn to coating application processes and the monobooth design for promising low temperature cure systems. Finally, researchers will further refine the processes developed and work with the project partner to build a prototype lab-scale oven. Potential energy savings from lower operating temperatures will be estimated.

Milestones

This three-year project began in January 2015.

- Initial polymer samples formulated and tested in both solid and metallic color basecoat/clearcoat applications (Completed).
- Critical process variables and operating parameters (curing temperature, curing times, etc.) defined (Completed).
- Coating chemistry selected and associated coating system design requirements identified (2016).
- Fabrication and installation of lab scale equipment (2017).
- Production simulation and coating optimization (2017).

Commercialization

At the conclusion of the project, researchers will work with automotive manufacturing plants in North America to further test and implement the new technology. Both PPG and Dürr Systems USA have established relationships with multiple automobile manufacturers.

Project Partners

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