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## UV-Cured Powder Coating Developments

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# Innovation and Sustainability Drive UV-Cured Powder Coating Developments

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## Introduction – The Innovators Challenge

Customers are demanding products and services that cost less and add value. Innovating providers of services and manufacturers of products recognize the importance and challenge of simultaneously adding value and reducing costs; not as opposing or conflicting goals, but as profit opportunities. UV-cured powder coating meets the innovator’s challenge. It combines chemistry and curing technology, and it is both value adding and cost reducing. UV-cured powder coating is a safe, environmentally friendly and high-performance finishing material. It is efficiently applied, uses a minimal amount of energy and has an exceptionally low cost of quality. UV-cured powder coatings are used on a wide variety of heat sensitive substrates including medium-density fiberboard (MDF), plastics, composites and pre-assembled parts.

## Process Overview

The UV-cured powder coating application process illustrated in Figure 1 has four short and quick process steps. The part is grounded and the electrostatically charged UV powder is easily and uniformly sprayed onto the part. Once the powder is applied, it is melted; coalescing and wetting out on the part’s three dimensional surfaces. The final step is a virtually instantaneous cure with UV light.

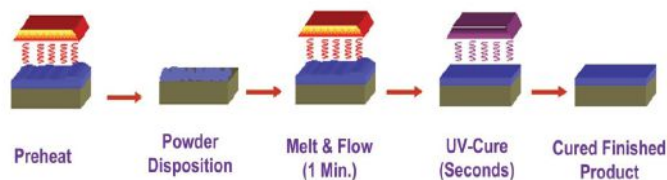


Figure 1: UV-Cured Powder Coating Application Process

The critical distinction of UV-curing from other finishing processes is the separation of the melt/flow step from the curing step. In other processes, melt/flow-cure is a continuous step, and it is not possible to determine when the melt/flow is

completed and curing begins. UV-curing separates these steps and reduces the amount of thermal energy necessary to melt/flow the coating. This decreases variability in the application of the coating material and increases the finish quality and material performance.

## UV-Cured Powder Coatings Market

UV-cured powder coatings and application systems first were developed and commercialized in the late 1990s and 2000s. These initial systems were small in scale and designed for product-specific applications – an assembled electric motor and an automotive radiator. In early 2002, two UV powder on wood (medium-density fiberboard, MDF) systems were built in North America, and at that time, there were about six UV-cured powder coating systems in Europe.

The objective of these systems was not to compete with traditional thermoset powder coatings, but to expand the penetration of industrial powder coating into new markets. It was hoped that UV-curing technology would enable specific product and substrate applications that could not be accomplished with thermoset powder coatings. Typically, thermoset powder coatings need 30 or more minutes and at least 300°F to cure. There are “low temp” thermal powder coatings that will cure at 250°F in 30 minutes. These low temp finishing systems are

Substrate	Pretreatment	Adhesion <sup>A</sup>	Impact Resistance <sup>B</sup>	Pencil Hardness <sup>C</sup>
Acrylonitrile butadiene styrene (ABS)	Yes	5B	35"	2H
Polyamide/polyphenylene ether (PA/PPE)	No	5B	50"	2H
Fiberglass pultrusion	Yes	5B	50"	2H
Sheet Molding Compound (SMC)	Yes	5B	50"	2H

NOTE:  
<sup>A</sup> ASTM D 3359 Method A  
<sup>B</sup> NEMA LD3-2005, 3.8 ½ lb steel ball 1.5" diameter  
<sup>C</sup> ASTM D 3363 Scratch Resistance, Wolff-Wilborn

Table 1: UV Powder Coating Performance Results on Various Plastics Substrates

designed for MDF substrates, are more expensive than standard thermoset powder coatings, difficult to handle, have unique storage and shipping requirements and ultimately have limited market and product application potential. The time and energy advantages of UV-cured powder coating make it ideal for heat sensitive substrates such as MDF, plastic and composite, as well as assembled products.

### New Opportunities for Plastics

UV-cured powder coating chemistry has improved since its introduction in the late 1990s, and developments and improvements are continuing. UV-cured powder manufacturers and applicators have continued to push the R&D envelope, creating more durable and higher performance coatings for interior applications on various substrates and product applications. It is well known that heat exposure can cause physical deformation of plastic materials. The fast process and the low amount of heat used to melt and flow the powder coating make the UV-cured powder coating process a good finishing material for plastic substrates. Most plastics are non-conductive and require additives to make them conductive and suitable for electrostatic powder coating. Often, it is a conductive primer that is applied to the surface, making it conductive. There are a variety of conductive primers available, and their use makes UV-cured powder coatings suitable for various types of plastic substrates (Table 1 on previous page).

### Pre-assembled Parts and Components

Pre-assembled parts were the first products finished with UV-cured powder coatings. These were a fully assembled and harnessed electric motor and a radiator sub-assembly for a light duty truck. Each of these products contained a variety of heat-sensitive materials that were not damaged in the UV-cured powder coating finishing process, maintaining the quality and integrity of the finished product. Typically, heat sensitive elements and materials will degrade or deform when exposed to heat. Once damaged, they make the finished product unusable. These may be plastics, rubber seals, electronic components, gaskets or lubricating oils. The component parts that require finishing are normally finished as sub-assemblies or pieces and parts. Often, this finishing is costly and sub-optimal in regard to the final product need or use and is often more decorative than functional. Because UV-cured powder coating is very fast and uses a minimal amount of heat, it is possible to build a fully assembled product and finish it without damaging the internal components. To fully exploit the benefits of UV-cured powder coating of assembled products, it is necessary to change traditional thinking of manufacturing and assembly and evaluate its cost and time advantages in a total product cost model.

### Sustainable

Manufacturers and service providers not only are challenged by the demand for innovative products and services, but are being further challenged to assure sustainability up and down



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the supply chain. Customers make intentional and conscious buying decisions based upon criteria and standards that define products and services as “sustainable.” Consumers are actively seeking materials and processes that are safe – safe to make, safe to use and safe to dispose. UV-cured powder coatings meet all three of these “safe” requirements. They do not contain solvents, VOCs or HAPs (hazardous air pollutants) and are non-toxic. Manufacturing and use of UV-cured powder coatings do not require any permits, special air handling, operator breathing devices or flammability restrictions or controls. UV-cured powder coating has the smallest carbon footprint of any commercially used coating material<sup>2</sup>. These results are from third party evaluation and testing of various types of industrial coating materials. A safe and low-risk work environment lowers insurance and operating costs.

The application and handling of powder coatings are safe and easy-to-use. Depending on the type of application system, color changes can be manually accomplished in minutes or instantly with automatic equipment. Material handling and cleanup are very simple and easy. A spill can be swept up or vacuumed with no residual damage to equipment or property. Again, depending upon the type and complexity of the application system, powder can be manually or automatically sprayed. A major benefit of

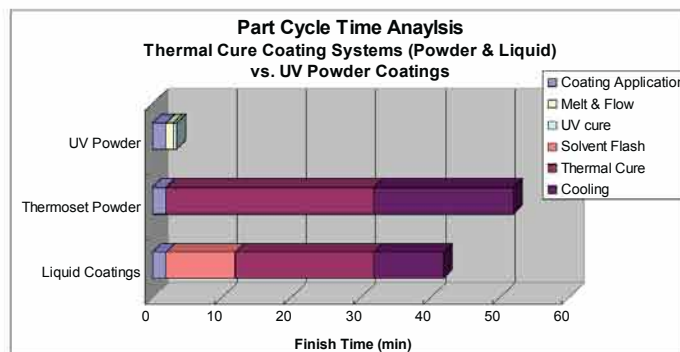


Figure 2: Finishing Technology Time Analysis by Process Step

powder coatings is the ability to re-capture sprayed powder coating material and re-introduce it into the finishing operation. Using a reclaim application system, it is possible to achieve transfer rates of greater than 90 percent. Residual powder can be recycled into a manufacturing stream. The EPA considers powder coatings a “Pollution Prevention” coating technology<sup>3</sup>. UV-cured powder coating reduces or eliminates the various and numerous material handling, permitting, environmental and waste disposal costs associated with the use of liquid coatings – regardless of type of coating, whether solvent-borne, low VOC, waterborne or UV liquid.

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A UV-cured powder system can produce more material in a given period of time; increasing operating capacity, reducing WIP inventory, lowering the cost of quality, using less energy per part produced and increasing cash flow.

### Lean Manufacturing

Companies are using lean manufacturing principles to eliminate unnecessary costs and increase profitability. UV-cured powder coating and application technology meets all the criteria of lean manufacturing. The focus of lean manufacturing is to provide value-add processes with less work through the elimination of waste. The Part Cycle Time Analysis in Figure 2 (on page 16) identifies and measures the process steps of UV-cured powder coating, thermoset powder coating and liquid coating. The chart clearly and explicitly demonstrates the lean advantage of UV-cured powder coating compared to the other two materials and processes. The material application time for each is comparable; however, the total time to produce a finished product using UV-cured powder coating is significantly faster. This time advantage has cost and economic benefits that

may not be readily apparent. A UV-cured powder system can produce more material in a given period of time; increasing operating capacity, reducing WIP inventory, lowering the cost of quality, using less energy per part produced and increasing cash flow. UV powder coatings clearly demonstrate the lean attributes through adding value and reducing wasteful time and energy in the finishing process.

An additional benefit and cost advantage of a UV powder application system is its compact size and small plant footprint. A UV-cured powder application system has a typical footprint of 2,000 sq. ft. A comparable thermal liquid finishing system has a footprint of 16,000 sq. ft. Assuming a net cost of \$7.50 per square foot for factory space, the cost savings of a UV-cured powder coating system is \$105,000 per year.

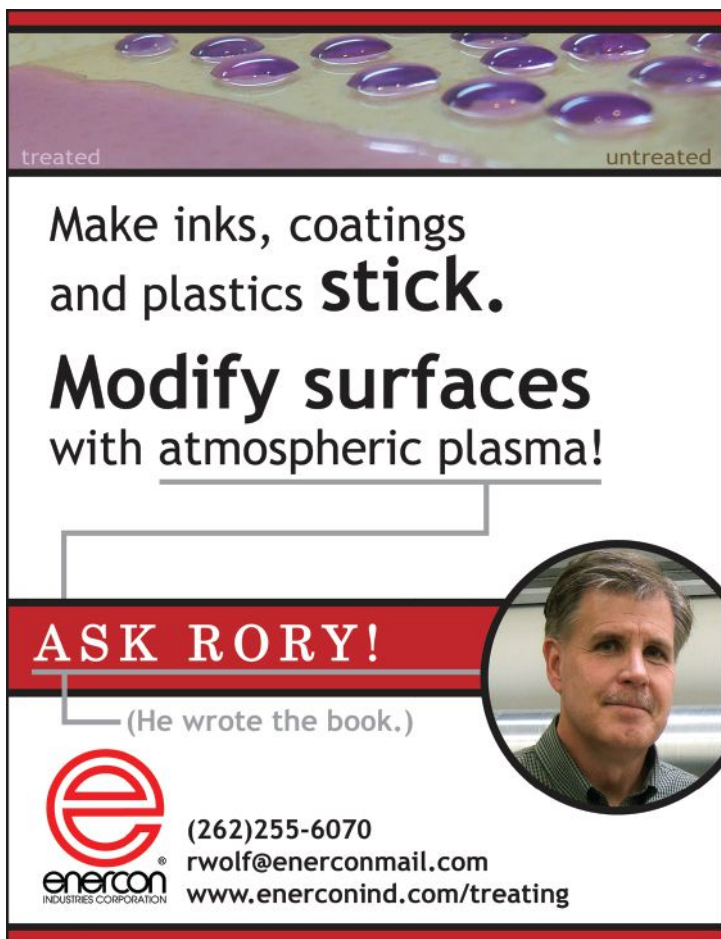
### Conclusion

The demand for innovative and sustainable products and services will continue to grow, and market opportunities for UV-cured powder coatings on various substrates and assembled products will continue to develop. Adoption of UV-cured powder coatings will be accelerated by new developments in chemistries that expand the durability and performance of these coatings. Use on plastics and composites will increase as newly developed plastics and composites are brought into the market. UV-cured powder coatings can cost-effectively finish these materials and add greater market value. UV-cured powder coatings have unique and inherently sustainable features not found in other finishing materials. Their significant and compelling lean manufacturing attributes are part of the reason UV-cured powder coatings and application technology is gaining in popularity. There is an exciting and profitable future for UV-cured powder coatings used to finish heat sensitive substrates and assembled products. ■

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