Can Prepainted Metal Benefit Your Production Process?

Technical Paper
Today, an increasing number of end-use manufacturers are converting to prepainted metals to achieve multiple production benefits, from speeding up the ability to respond to market demands…to reducing production cycle time and costs. Concurrently, prepainted metal allows product design teams to significantly expand the options they can choose from to meet consumer needs with an extraordinary palette of colors, sheens and cosmetic effects for appliances, buildings, furniture and other metal products.

The global prepainted metal industry is well developed, with more than a 50-year history that demonstrates the efficiencies that can be gained by using outsourced prepainted metal. The appliance industry adopted the prepaint methodology with refrigerator doors and case bodies more than 30 years ago. Use of prepainted metal has expanded significantly since then into numerous industries with great success.

This paper is intended to help engineers and technical teams assess their current operations to determine if prepainted metal could be used in their operation to reduce production costs and time, while improving the coating quality on parts and products. It provides a thorough review of the prepaint versus post-paint coating process, benefits of prepaint, manufacturing and design considerations.

Industries That Can Benefit from Prepainted Metal

Two major market trends are driving the conversion to prepainted metal: consumer demands and global manufacturing efficiency.

From the consumer perspective, there is a trend toward color as a way to define the personal home style of consumers. Wanting both color and finish options, consumers also look for durability and performance in their appliance coatings.

From a manufacturing perspective, the use of prepainted metal continues to grow as manufacturers embrace the multiple advantages it provides…from lower production costs and the ability to react more quickly to market needs…to improved product quality in an increasingly competitive global environment. Handled properly, prepainted metal maintains a quality-consistent surface often not achieved by post-paint. This delivers a significant benefit in design aesthetics for the product. Prepainted metal also allows designers more cosmetic freedom since almost any color, pattern or texture can be applied to a range of metal substrates.

In the highly competitive residential refrigerator business today, companies in the industry are looking for ways to continually differentiate. The finish on the refrigerator is a high-value differentiator. Consumers can select from a variety of specialty finishes including fingerprint-resistant stainless steel coatings, metallics and other special effects, and a range of colors including custom matching.

The construction industry is another sector where prepainted metals can be used to differentiate projects, from architectural designs to roofing panels. Prepainted metal enables architects, product designers and manufacturers to reinvent products of all types.

Innovative shapes, colors, patterns and textures are all possible with prepainted metal. In fact, prepainted metal is being used as a design differentiator around the world in ways not previously considered by many end users.
Prepainting of metal, substrate can provide great benefits to many industries including:

- Construction (roofing, walls, soffits and fascias, garage and entry doors, storage units)
- Appliance (laundry, refrigeration, dishwashers, small appliances)
- HVAC (heating and air conditioning units)
- Transportation (tractor trailers, trailer van panels)
- Furniture (filing cabinets, desks, storage units, shelving, point-of-purchase displays)
- Other Goods (containers, lighting fixtures, electrical cabinets, lockers, clocks)

Coil Coaters and Coating Process
Prepainted metal is produced at coil coating facilities by adding paint or film coatings to properly cleaned and pretreated strip metals (coils). The steel or aluminum substrate is delivered in large coil rolls from the mill. During the coil coating process, metal coils are unwound, cleaned, pretreated, painted, cured and rewound all in one continuous process.

This coating process is a highly-efficient way to coat metal before fabricating finished components. It provides a high-quality, uniform and reproducible surface finish with no loss to surface quality or beauty. Every inch of surface is cleaned and treated when the metal is flat, which is generally not possible when painting is done after parts are formed.

Coil coaters typically invest tens of millions of dollars in equipment that is potentially capable of line speeds in excess of 600 feet per minute, depending on the facility's process capability, metal substrate thickness and width. Coaters provide inspection and physical testing to ensure all cosmetics and physical properties meet the manufacturer's end-use requirements.

The quality of the prepainted finished coatings is excellent—smooth and consistent with very good corrosion resistance related to the coil coating process. The metal substrate is aggressively cleaned with alkaline and mechanical steps; there are controlled pretreatment applications used, and a corrosion-inhibiting primer (when applicable) is typically applied before the colored top coat. The finished painted coils can be shipped in cut-to-length or coil form for end-use fabrication to the manufacturer.

Benefits of Prepainted Metal
Prepaint is attractive for many reasons including streamlining the supply chain and launching new products to the market more quickly, responding to market demands.

1. **Beauty and Design Innovation**
   Coil-coated metal is visually appealing, from the consistent quality of the finish to color, texture and pattern options, which are nearly endless. Architects and product designers have maximum flexibility for design and production, whether developing a new appliance or a one-of-a-kind, iconic commercial project.

2. **Speed to Market**
   Quick execution of new designs is key in highly competitive industries like the consumer and industrial appliance segment. When design teams and manufacturers can shave weeks to months from the design and production process to deliver new designs to market more quickly, both the manufacturer and for consumers benefit. Prepaint significantly reduces time to market because manufacturers can respond to product changes much more quickly on their production lines.
3. Manufacturing Efficiency and Cost Savings

Manufacturers with a post-paint process (in-house or outsourced) that move to prepainted metal can dramatically reduce production cost and time. These manufacturers can more actively embrace true “Lean Manufacturing” with shorter cycle times and reduced inventory (WIP). Prepaint manufacturers can expect a shorter time frame from idea conception to trial and customer availability. They will reduce or eliminate costs associated with operating post-paint lines, gain energy savings, minimize waste and emissions, and ensure easier environmental regulatory compliance. From a supply chain standpoint, lead times are typically reduced and logistics greatly streamlined. When you consider the cost of capital for one post-paint line is estimated at $1 to $2 million dollars and the national average cost of plant space can be as much as $100 a square foot, the cost savings benefits yielded from prepaint product add up fast. Paint is often one of the more costly steps in production of a product. By letting coil coaters and coating manufacturers focus on the technical aspects of ensure the highest quality, most efficient paint process possible, manufacturers can focus on manufacturing the product.

Valspar Pre-paint Value Model

4. HSA/Eco-Friendly

The sustainability aspect of switching to prepaint is significant. Post-paint lines are typically on the EPA’s list of highest waste pollution. Cleaning and pretreatment of the part before it is painted creates a lot of waste, and typically, three times more paint is required in the powder coating process than is the coil coatings used in the prepaint process.

Coil coaters can help remove the majority of the regulatory compliance requirements for end-use manufacturers by taking the painting process out of the manufacturing plant and into environmentally-compliant coil coating facilities. This process can eliminate the manufacturer’s in-house paint shop, which results in reducing waste, lowering energy consumption, and minimizing regulatory compliance headaches.
Coil coating facilities help manufacturers and the environment by:

- Reducing or eliminating waste handling costs
- Easing burden of record keeping, reports and permits
- Curbing electrical costs and water use
- Lowering maintenance costs
- Eliminating the facility's post-paint process “footprint,” opening up multiple opportunities for use of the freed-up square footage

For years, coil coaters have been working to reduce waste and emissions with the latest technologies and ongoing field research. Because of these efforts, coil coating is the most efficient process known for applying finishes to metals. The coil paint process is highly regulated and employs EPA-approved water and pollution equipment that makes it possible to apply coatings to metal at high speeds with minimal environmental impact. Prepaint process and technical innovations include dried-in-place pre-treatment applications to reduce water use and minimize waste stream management concerns, paint curing in seconds using convection, induction, infrared or near-infrared curing; and elimination of volatile organic compounds (VOCs) by collecting the VOCs from solvents and using thermal oxidizers to turn those compounds into fuel to cure the coating. Prepainted metal can be RoHS-compliant, with conversions to chrome-free applications in certain industries gaining in popularity for several years.

5. **Coating Quality and Durability**

With quality coatings, prepainted metal substrates can be made virtually weatherproof, and corrosion and UV resistant, holding up better than post-painted surfaces. The excellent corrosion resistance yielded from prepainted galvanized steel, for example, is a combination of a zinc layer used on a galvanized substrate, aggressive alkaline cleaning, pretreatment and corrosion-inhibitive primer before the top coat is applied.

- **Edge corrosion:** Prepainted metal with cut-edges is designed to reduce corrosion and can corrode significantly less than post-painted metal with no exposed edges. And, prepainted metal can be shipped in a large coil form while maintaining an intact quality surface. With advances in polyurethane and polyester primers, better cut-edge protection is available for HVAC products that require cut outs and notches. These primers can deliver high film build, provide superior adhesion performance and are more flexible.
- **Dry film thickness:** Dry film thickness for a prepainted product's cosmetic or “show” surface is commonly ~1 mil compared to potentially 3 to 5 mils of powder coating in post-paint.
- **Finish quality:** Prepaint is a more controllable coating process with smooth application, ensuring the highest quality finish across the entire coil width.
- **Outdoor ruggedness:** For coatings used on buildings, HVAC equipment and other exterior applications, reputable coatings manufacturers conduct substantive and ongoing real-world exposure testing. Accelerated corrosion salt spray and humidity testing is also available to help ensure coatings will perform well after long-term simulated exposure to harsh environments.
- **Orange peel finish:** Prepaint can reduce or eliminate the “orange peel” finish common to post-paint applications because it offers excellent flow properties at relatively reduced film thicknesses.
- **Durability:** With a myriad of high-quality color and finish options exhibiting rugged durability, the consumer benefits from products produced using prepainted metal.
- **Superior color retention for exterior products:** Appropriate pigmentation is critical in formulating a quality coating finish that will resist fading. Not all pigments are suitable for every application. For example, exterior high-performance architectural coatings require high-end raw materials with outstanding properties, particularly heat
resistance and UV resistance. Certain colors are more affected by the environment than others. Color warranties are typically based on the percent of organic versus inorganic pigments used to create the final color. Bright colors, such as yellows, oranges and reds, fade faster and are typically formulated with organic pigments to meet the desired finished color space. Ceramic and select inorganic pigments offer the most durability with the highest resistance to fading. They are the most heat stable, chemically inert, ultra violet (UV) and weather resistant pigments.

- **ASTM D 2248 Testing:** Prepainted parts (specifically those for home laundry or fabric care in the Appliance industry) perform well in in detergent-resistance testing to assess resistance to failure in an accelerated manner. Panels are typically emerged into a heated alkaline bath for 10 days and/or 240 hours. This test is most commonly used for home laundry and dishwasher parts.

6. **Formability versus Durability**

   Advances in coating technology have made prepaint coatings harder and more durable while still maintaining formability. And, prepainted metal can be easily joined using adhesives or mechanical assemblies. Weldable primer applications are also available.

7. **Fingerprint Resistance**

   Stainless steel remains a popular choice for residential and commercial appliances, yet showroom managers and consumers dislike the fingerprinting and smudging that comes with stainless appliances. There is growing demand from consumers and manufacturers for fingerprint-resistant clear coatings to reduce smudging. With prepaint, excellent fingerprint-resistant clear coatings and tinted clear coatings are available. Typically, sheen or gloss is reduced while still maintaining the brush pattern visible in the stainless steel.

**Manufacturer Considerations With Prepainted Metal**

- **Timing:** Are you planning to downsize, combine plants or make any other major changes in your operation? If so, now might be a good time to make the conversion.
- **Cost Cutting:** Eliminating in-house, post-paint production may be the best way to reduce costs while improving the quality of your coating.
- **Major Capital Improvements:** If there are other capital improvements underway, the timing might be right to change to prepainted metal.
- **EPA and Environmental Regulations:** Using prepainted metal will eliminate the need and added cost of keeping up with regulations as they become increasingly more stringent from clean-up and compliance programs to fines, penalties and legal actions.
- **Inventory:** You’ll want to time your conversion with the stock you have in hand with paints, chemicals, solvents, cleaners, applicators, work-in-progress (WIP), and bare, pretreated, primed or painted parts.
- **Insurance:** Coverage for your part finishing area(s) can be eliminated.
- **Cleaning/Waste Treatment Removal:** These costs can include cleaning supplies and tasks, sludge removal and maintenance.
- **Space:** Consider all of the factory space that can be freed up, from the post-paint operation on the floor to stocking of materials needed for the painting process.
- **Purchasing:** The role of Purchasing will be significantly reduced including sourcing, order follow-up, status reporting, negotiating specs and prices, standard cost development, purchase orders, damaged goods and stocking programs.
• **Operating Costs:** Many operating costs can also be eliminated including energy, filters, delays, rejects, equipment maintenance, lubricants, shutdowns, rework and spare parts to keep equipment running.

• **Finishing and Clean Material Handling:** Additional costs include receiving, requisitioning, cycle planning, preventive maintenance, inspecting, spoilage, disposition and maintenance.

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**Design Process for Prepainted Metal**

Even if manufacturers don’t plan to begin production using prepainted metal, they can evolve to prepaint production by planning for it during the design phase. Recommended steps for a team approach to the prepaint design process include:

**Broaden The Design Team:** Invite engineers, paint chemists, marketing, sourcing and supply management, coaters and manufacturing to join discussions during the design process. Emphasize innovation and problem solving to create a seamless transition from design through manufacturing to the end user.

**Establish Coating Objectives:** Set coatings objectives on the front end of the project to help guide the design process.

**Explore Ways to Differentiate:** A unique appearance for products can be achieved through innovations in color and texture. A manufacturer’s coating partner can help weigh the pros and cons of various options. Rather than delivering the coater a chip to color match once the design process is complete, ask them to share trends in both existing markets and other industries concerning colors and finishes. Coatings manufacturing partners can help balance design, performance, functionality and cost when recommending coatings options.

**Establish Vision During Initial Design Phase:** Review proposed part drawings early in the process with attention toward finish options such as color, texture and gloss. Typically the initial design phase is comprised of several planning meetings with the end vision becoming clearer as meetings progress.

**Prepare Lab Display Panels:** The team can explore cosmetic options by having the coatings partner prepare lab display panels with various coatings to review.

**Plan for Form and Function:** The team will want to ensure the coating meets the requirements of both form and function to avoid issues in the launch phase. This will involve weighing the pros and cons of various coating types to meet aesthetics, flexibility, durability and other performance objectives.

**Apply Lean Methodologies to the Production Process:** The team should assess the entire coating production process to achieve efficiency, from sourcing raw materials to Lean manufacturing. End-use production lines may require only minor tweaking to accommodate prepaint.

Through a strong and early design partnership with the coating manufacturer, applicator and substrate supplier, many benefits from use of prepaint can be realized. Through the team-design approach, all involved members of the immediate supply chain have a voice and can actively contribute to the success probability offered by a prepaint process model.

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**Design Guidelines for Prepainted Metal**

When designing for metal coatings, consider the following:

**Substrate Type:** The general performance characteristics of the selected substrate will help guide coating selection, including surface topography, yield, tensile and elongation (YTE).
**Pretreatment Designation:** Determine whether the application requires Restriction of Hazardous Substances (RoHS) compliance.

**Durability versus Formability:** Understand the specifics around minimum durability requirements such as scratch-resistance and hardness with the knowledge that these characteristics will likely require a compromise with general prepaint flexibility. Design for prepaint with as generous-as-possible bend radii to allow for maximum factory formability.

**Finish requirements:** Appliance “industry standard” prepaint finish applications are generally comprised of a “primer” application and a “finish coat” application.

**Fold Design:** Avoid exposed edges on final part design, allowing for an engineered fold to “hide” cut edges.

**Multiple Design Finishes:** A large range of finish colors and effects are available in prepaint coatings, as well as multiple gloss levels.

**Mechanical Post-Embossing:** For finished part applications that require a mechanical post-emboss, recognize and design for additional finished thickness. Mechanical embossing also can lend structural rigidity to an end-use part.

**Conclusion: Determining if Coil Coating is Right for Your Operation**

Manufacturers in many industries continue to discover the benefits that can be achieved from prepainted metal to differentiate their products while improving speed to market. Prepaint opportunities are thriving in multiple industries.

A manufacturer’s coatings partner can help complete a cost-benefit analysis of this coating solution. The National Coil Coating Association (NCCA) offers a cost Comparison Analysis tool that allows companies to quantify the long-term manufacturing savings in converting to coil coated material. This detailed form is divided into three sections: Inventory Costs, Fixed Paint Equipment Costs and Operating Costs to identify the all cost components as you assess the potential savings that can be achieved.

www.coilcoating.org/index.php/education/other-tools

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