Description

Image

Image caption

(1) Powder coating material after paint production © Hardcoreraveman at Wikimedia Commons [Public domain] (2) Application of powder coating (spray process) © Hardcoreraveman at Wikimedia Commons [Public domain] (3) Powder Coated Bicycle Parts © 802bikeguy at Wikimedia Commons (CC BY 3.0)

The process

ELECTROSTATIC POWDER COATING is an efficient, widely used process for applying decorative and protective finishes to metallic or conducting components. The powder is a mixture of finely ground pigment and resin that is sprayed through a negatively charged nozzle onto a surface to be coated. The charged powder particles adhere to the surface of the electrically grounded component. The charge difference attracts the powder to the component at places where the powder layer (which is insulating) is thinnest, building up a uniform layer and minimizing powder loss. The component is subsequently heated to fuse the layer into a smooth coating in a curing oven. The result is a uniform, durable coating of high quality and attractive finish. Powder coating is the fastest growing finishing technology in North America, representing over 10% of all industrial finishing. In polymer flame coating, a thermoplastic in powder form (80-200 µm) is fed from a hopper into a gas-air flame that melts the powder and propels it onto the surface to be coated. The process is versatile, can be mechanized or operated manually, and can build up coatings as thick as 1 mm. A wide range of thermoplastic powders can be used and the process is cheap. The disadvantages: line-of-sight deposition, and surface finish that is inferior to other processes.

In FLUIDISED BED COATING the component, heated to 200 - 400 C, is immersed for 1 to 10 seconds in a tank containing coating powder, fluidized by a stream of air at 0.1 - 0.5 atmospheres. The hot component melts the particles, which adhere to it, forming a thick coating with excellent adhesion.

In ELECTROSTATIC BED COATING the bed is similar but the air stream is electrically charged as it enters the bed. The ionized air charges the particles as they move upward, forming a cloud of charged particles. The grounded component is covered by the charged particles as it enters the chamber. No preheating of the component is required but a subsequent hot curing is necessary. The process is particularly suitable for coating small objects with simple geometries.

Process schematic

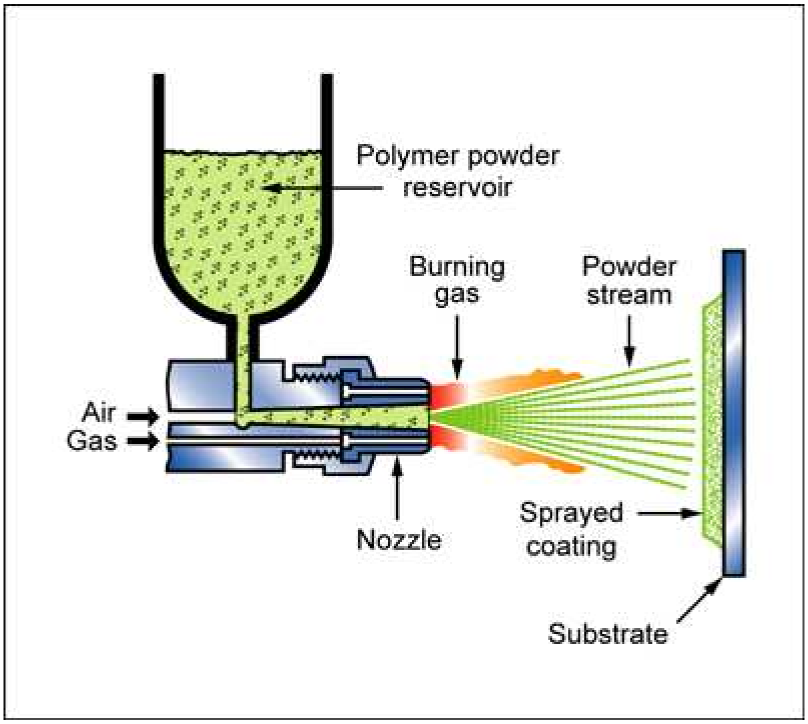

Figure caption

Polymer coating

Material compatibility

Ceramics	✓
Composites	✓
Glasses	✓
Metals - ferrous	✓
Metals - non-ferrous	✓
Natural materials	✓

Function of treatment

Corrosion protection (aqueous)	✓
Corrosion protection (organics)	✓
Friction control	✓
Thermal insulation	✓
Electrical insulation	✓
Decoration	✓
Color	✓
Reflectivity	✓
Surface texture	✓

Economic compatibility

Relative tooling cost	low
Relative equipment cost	medium

Labor intensity	low

Physical and quality attributes

Surface roughness (A=v. smooth)	B			
Curved surface coverage	Good			
Coating thickness	7.87	-	39.4	mil
Coating rate	10	-	30	µm/s
Surface hardness	10	-	16	Vickers
Processing temperature	116	-	368	°F

Process characteristics

Discrete	✔

Supporting information

Design guidelines

Powder contamination (other colors, incompatible resin types, or other foreign material) is devastating to film appearance and properties. Color post-modification is not possible with powder coating as in tinting of liquid paints. Powder coating applications are limited to those that will sustain the processing temperatures required for polymer melting, curing, and film formation. The process can be easily automated, and can create thin films (50 µm), with good edge cover. Thick films can be applied in a single application, and the coating toughness is generally better than its liquid-based counterparts. Masking is easier than with other processes. Powder coating are available in a wide variety of glosses and textures that are packaged as 'ready to use' coatings. Powder coating gives good 'wrap around' without requiring re-positioning the component.

Technical notes

Powder coating is routinely applied to components of steel, aluminum, magnesium, brass, copper, cast iron and most metallic alloys. The surface is first cleaned, pre-treated with iron phosphate and dried. It can be applied to non-metals if their surface is first made conducting. The development of powder that can be cured at lower temperatures has allowed powder coating to be applied to non-metal surfaces such as ceramics, wood and polymers. Coating materials are typically nylons, polyesters, polyethylene, polypropylene, polyvinylchloride (PVC), polyvinylidene fluoride (PVDF) and ethylene acrylic acid (EAA) copolymers. For polymer flame spraying, Almost all metals, ceramic and even wood can be coated by this process - unlike electrostatic powder coating, it is not necessary for the surface to be conducting. Typical coatings are low and high density polyethylene, polypropylene, thermoplastic polyesters, and polyamides (Nylon 11). Pre-heating of the surface to 150-250 °C may be necessary. For fluidized-bed coating, a clean surface is required. Almost all metals, ceramic, masonry (but not wood) can be coated - when electrostatic, the surface must be conducting. Fluidized-bed coating works well with nylons, PVC, acrylics, polyethylene, polypropylene, silicones, EVA and polystyrene. The useable powder size range is 1-200 µm, although 20-200 µm is best. The process gives good coverage, particularly of irregular shapes, allowing simultaneous coating of external and internal surfaces. Thick coatings are possible in a short time, with little waste of powder. The size of component is controlled by size of the powder bed and preheating oven.

Typical uses

Automotive industry: wheels, bumpers, hubcaps, door handles, decorative trim and accent parts, truck beds, radiators, filters, numerous engine parts. Appliances: front and side panels of ranges and refrigerators, washer tops and lids, dryer drums, air-conditioner cabinets, water heaters, dishwater racks, cavities of microwave ovens; powder coating has replaced porcelain enamel on many washer and dryer parts. Architecture: frames for windows and doors and modular furniture. Consumer products: lighting fixtures, antennas, electrical components, golf clubs, ski poles and bindings, bicycles, computer cabinets, mechanical pencils and pens.

The economics

For electrostatic polymer coating, the capital cost is medium, the tooling cost low, and the equipment is not portable - a workshop process. The size of component is controlled by the capacity of the equipment. The coating rate is between 5 and 20 µm/s. Products can be safely handled 5 to 10 minutes after processing. For polymer flame spraying, the capital cost is low, the tooling cost is low and the equipment is portable. There is no limit on the size of component. The coating rate is between 10 and 30 microns/second. Components can be safely handled 5 - 10 minutes after processing. For fluidized-bed coating, the capital cost is higher than that for polymer flame spraying; the tooling costs are low. The coating rate is between 20 and 50 microns/second. Components can be safely handled 5 to 10 minutes after processing.

The environment

The processes use no solvents and releases almost no volatile organic compounds, (VOCs) so operators are not exposed to high levels of toxicity. Air pollution, fire hazards, and volatile organic compounds are low. Excess or over-sprayed powders are recycled, blended, and re-sprayed with virgin material, which increases utilization up to 99 % by weight.

Links

MaterialUniverse

Reference