

Theory & Models

What is coating?

A coating is a covering that is applied to the surface of an object, or substrate, and then a solid coating film or layer are formed on the substrate after the drying process.

In typical applications, the coating film should not be peeled off from the substrate and the purpose of coating film may be decorative, functional, or both.

In some other certain applications, a free stand film can also be made by the coating technology after the wet film is dried and peeled off from the substrate.

Function of Coatings

Coatings serve various purposes, from protecting against corrosion and abrasion to providing aesthetic appeal and specific functional properties like electrical conductivity. They are applied as a liquid or powder and transform into a solid, protective film on a substrate (the material being coated).

Protective: Shielding against environmental factors like corrosion, UV radiation, chemicals, and wear.

Decorative: Enhancing appearance with desired color, gloss, texture, and patterns.

Functional: Imparting special qualities such as electrical conductivity, thermal insulation, anti-fouling, or anti-microbial properties.

Coating composition		
Liquid coating	Powder coating	Raw materials
Formula design		

Basic Coating Composition

A typical coating formulation is a blend of several key ingredients:

- 1) Binder (Resin/Film-Former): The backbone of the coating that forms a solid film and adheres it to the substrate. Examples: Natural and synthetic polymers like latex, polyethylene, waxes, and various resins.
- 2) Pigments/Extenders/Fillers: Provide color, opacity, and can also contribute to corrosion inhibition. Inexpensive materials used to add bulk, reduce cost, and enhance certain mechanical properties of the coating. Examples: Titanium dioxide (for whiteness) and extenders or fillers (used to reduce cost and improve performance).
- 3) Solvent (Carrier/Dispersant): Dissolves or disperses the binder and pigments, controls viscosity for application, and then evaporates to form the solid film. Examples: Water (for water-based coatings), organic solvents, or no solvent (for powder coatings).
- 4) Additives: Small-quantity components that improve specific coating properties. Examples: Defoamers, wetting agents (surfactants), flow modifiers, hardeners, preservatives, and UV stabilizers.

Testing/Characterization		
ASTM	ISO	GB
Internal methods	Others	

Performance testing:

Coating performance testing evaluates a coating's quality, durability, and protective properties through standardized methods like adhesion, hardness, corrosion, and weather resistance tests. These tests assess physical and chemical resistance to ensure the coating meets required standards for longevity, proper application, and specific environmental conditions. Testing categories include **laboratory simulations**, **outdoor exposure**, and **empirical quality control** tests, often following ASTM or other industrial guidelines.

Application processes		
Dispersing and milling	Surface treatment	Spray/Spin/Dip/Bar /Casting/Roll
Drying/Curing process		

Application process of coating:

A coating application process involves preparing the substrate, applying a liquid or powdered coating material using methods like spraying, dipping, rolling, or electrostatic deposition, and solidifying the coating through curing, baking, cooling, or solvent evaporation to enhance the substrate's properties. The specific process varies significantly based on the materials, equipment, and desired finish.

Key Steps in a General Coating Process

Substrate Preparation: Thoroughly clean the surface to remove contaminants like dirt, oil, or rust, which can affect adhesion and finish quality.

Application: Apply the coating material evenly to the prepared substrate.

Solidification: Allow the coating to solidify, often through processes like baking, air-drying, or UV light exposure.

Post-Treatment (Optional): Perform additional steps such as polishing, buffing, or applying protective layers for enhanced gloss or durability.

Reverse Engineering		
Ingredients separation	Optical	Composition & Element
Crystalline	Thermal	Particle size
Molecular weight		

Coating reverse engineering:

The process of analyzing a finished coating to **determine its composition, structure, and physical properties**, typically to replicate, improve, or understand a competitor's product, or to troubleshoot production issues by identifying deviations from the intended design. This process involves deconstructing the coating's formulation, identifying its layers (including their thicknesses and optical constants), and understanding the underlying chemical and physical principles.