Physical Vapor Deposition (PVD) technology

Embellish  Protect  Optimize
ARCEO Engineering is a specialty coil coater, offering high added value surface treatment solutions. Our aim is to offer our customers specialized solutions in the domains of metallic surface embellishment, corrosion and handling protection and process optimization.

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Physical vapor deposition (PVD in short) is a coating technique belonging to the branch of vacuum coating technologies. Using PVD it is possible to cover a surface with a solid material like aluminum, a metallic oxide such as titanium oxide \((\text{TiO}_x)\) or a ceramic material as titanium nitride \((\text{TiN}_x)\). This would not be feasible to achieve by roll coating due to material thermodynamic instability.

**How does Physical Vapor Deposition work?**

We vaporize the solid material from a metallic target to deposit it on a substrate in a vacuum environment (vacuum is used to reduce gas particle density, limit gaseous contamination and control gas flow).

Material vaporization may be obtained either by thermal heating or by sputtering (material removal by ion or atom bombardment). Sputtering is much more energy efficient as compared to thermal evaporation and it is a versatile technique on the point of material deposition. Sputtering can be used to deposit from pure metals to alloys. In addition, sputter atoms have a higher kinetic energy than evaporated atoms, and this is the reason why coatings produced by this process show an improved performance, that is, better adhesion to the substrate, dense crystallographic structures of excellent quality and uniformity.

**How is sputtering obtained?**

In the sputtering process argon atoms are injected in the vacuum chamber at pressures typically from 1 to 10mTorr; a dc voltage is produced between the cathode (substrate) to the anode (the coating material) that ionizes argon atoms creating a plasma (a hot gas phase composed by ions and electrons). Due to the dc voltage, the argon ions are accelerated to the anode where they collide removing atoms from the coating material. These atoms travel to the substrate where they eventually settle forming the coating.

**What does ARCEO Engineering propose?**

ARCEO Engineering enhances the basic dc sputtering system by using a Magnetron Sputtering one. The advantage of this system is that electrons are confined to an area near the target instead of being attracted to the substrate, in other words, electrons are not able to damage the thin film being created. It also allows more stable plasma with a higher ion density increasing the probability of further argon atom ionization producing a higher bombardment rate into the target, which is translated into a higher material removal rate and therefore, a higher deposition rate of the coating on the substrate.

In this sense, a better coating quality is achieved because impurities “do not have time enough” to be deposited on the substrate surface.

PVD is useful to deposit pure metals, as it is the case for aluminum deposition for heat shield applications. In addition, by injecting small amounts of oxygen or nitrogen in the vacuum chamber (reactive sputtering process), compound materials such as titanium oxide \((\text{TiO}_x)\) or titanium nitride \((\text{TiN}_x)\) can be deposited.

These two compounds have very interesting industrial applications like decoration in indoor/outdoor architecture for titanium nitride \((\text{TiN}_x)\) and self-cleaning for titanium oxide \((\text{TiO}_x)\).
These two compounds have very interesting industrial applications like decoration in indoor/outdoor architecture for titanium nitride (TiNₓ) and self-cleaning for titanium oxide (TiOₓ).

**Figure 2. Magnetron Sputtering process.** Argon atoms are ionized in a strong magnetic field. They bombard the target causing the target atoms to be ejected toward the substrate and be deposited on its surface. The strong magnetic field near the target causes electrons from plasma to travel in a spiral trajectory along magnetic flux lines preventing thin film damage.

**ARCEO Engineering’s PVD-produced coil coatings**

ARCEO Engineering is proud to offer 4 PVD-produced coil coatings:

- **ShieldArceo.**
  Aluminum thin layer on aluminum-silicon coated steel for increased thermal efficiency and for heat shield applications.
  
  It provides high IR reflectivity, even in the visible range, good corrosion resistance and good formability.
  
  ShieldArceo is applied in the automotive industry to provide heat shield properties to the exhaust systems. It is also applied in the industrial food equipment as a heat shield material in ovens and heating devices.

- **ShieldArceo Hot.**
  Aluminum thin layer on stainless steel for combining anti-yellowing property and heat shield application.
  
  Besides providing the ShieldArceo’s advantages, ShieldArceo Hot also preserves the aesthetical aspect of the stainless steel under high temperature conditions (up to 600°C). It also provides high IR reflectivity up to 500°C and high resistance to thermal cycles.
  
  ShieldArceo Hot is applied in the pyrolysis ovens, infrared reflectors as well as industrial and domestic ovens.

- **ArenClean.**
  Nanometric titanium oxide (TiOₓ) coating on pre-painted flat carbon steel, pre-painted laminated zinc and pre-painted aluminum for self-cleaning applications.
  
  ArenClean is applied in the outdoor architecture preserving the original aspect of façades for a longer time. ArenClean confers two functionalities:

  ⇒ **Dust barrier:** The thin TiOₓ layer avoids dust to penetrate in the porosity of the top coat.

  ⇒ **Hydrophilic function:** Activated by UV’s, the TiOₓ layer allows water to evenly spread onto the façade, ensuring an easy removal of the fouling, without stains.

- **ArenGold.**
  Nanometric titanium nitride (TiNₓ) coating on stainless steel conferring it gold appearance for aesthetic indoor/outdoor applications.
  
  It keeps the brush aspect of the substrate alive, it has a good abrasion resistance, it provides an excellent coating adhesion, shock and bending resistance.
  
  ArenGold can be applied in the food industry as an aesthetic coating for food equipments and domestic appliances as it is tested against migration into food stuff.
ARCEO Engineering PVD line

ARCEO Engineering’s PVD line has 3 stages: vacuum, surface pretreatment, surface treatment and atmospheric pressure conditioning.

In order to achieve the atom transfer from the target to the strip of the coil a vacuum is created followed by argon injection. The argon gas is ionized and the ions are attracted by the target, hitting it and liberating target atoms. These atoms will then fill the vacuum chamber and deposit on the strip.

Prior to the PVD chamber, the substrate is pretreated by etching, which is a process similar to sputtering used to remove surface contaminants.

ARCEO Engineering PVD section has 3 chambers, each of them allowing a deposit of max. 30nm. Coils able to be treated in our PVD facilities are:

- Substrate width: (700-1500)mm
- Substrate thickness: (0.15-1.2)mm
- Substrate material can be flat carbon steel, laminated zinc, stainless steel, aluminum.

Our target are cylinders, which allow better efficiency since they turn on themselves and are able to cool off when not submitted to the magnetic field; also the wear is evenly spread on the cylinder.

Quality control (Point Labo)

At the end of the PVD line, the coated substrate is tested in the quality lab. All coated substrates are submitted to general visual inspection and according to the kind of coating that was deposited, specific tests are performed in order to determine and control coating quality:

- **ShieldArceo & ShieldArceo Hot**
  This coating is tested for the total IR reflectivity, energy efficiency, temperature resistance, corrosion resistance (salt spray test), formability, food contact, and some chemical agents such as detergents resistance and evanescent oil.

- **ArenClean**
  This coating is mainly tested for its contact angle. The cleaning capacity of a surface depends mainly on the contact angle of the water droplet on the surface.

- **ArenGold**
  This coating is tested for coating thickness and adhesion, shock resistance, bending resistance, coating adhesion and deformability (Erichsen test), hardness, abrasion resistance, corrosion resistance (Salt spray test and Volvo test), temperature resistance, chemical agent resistance (MEK), UV resistance, food safety and resistance to staining by foodstuffs.

Packaging

ARCEO Engineering offers different kinds of coil packaging that are upon request. The standard packaging consists of a basic “nude” packaging:

- 2 circumferential plastic strapping + carton protection of the strapping welding.
- 3 radial straps at 2,5 and 10 o’clock with plastic protection angles.

With our technical expert team, we are capable of offering a personalized, quick and efficient service. Do not hesitate to contact us if you are looking for high technological effective surface treatment solutions. It will be a pleasure to assist you!
ARCEO Engineering
Specialty coil coater

Convenient logistics location
- England
- France
- The Netherlands
- Germany

R & D approach

Roll Coating Business
- Enhancing infrared reflectivity
- Enduring a clean aspect of metallic substrates
- Embellishing surface metallic substrates

PVD Business

Visitors
Chaussee de ramioul 52
B-4400 Ivoz-Ramet
Belgium

Logistics
Rue Sompré 1
B-4400 Ivoz-Ramet
Belgium

www.arceo-eng.com
sales@arceo-eng.com
+32(0)4 236 96 32