Vacuum web metallizing

Advanced coatings for functional and visual applications

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Recent development in the science and technology of vacuum web metallizing and materials has resulted in the introduction of so many added value products to a very wide market. The market demand for more durable coatings to provide good barrier properties for food packaging and advanced coatings for holographic films have encouraged such developments and investments into new Materials and coating processes. This article outlines some of the recent developments in vacuum web metallizing and introduces new coatings for functional and decorative applications.

The old trend of using heavy packages made of Aluminium foil is now changed into using lightweight Aluminium metallized films such as Polypropylene (PP) and Polyester (PET) in a variety of food, medical and holographic applications. This results in energy saving since the production of Aluminium foil is highly energy intensive as compared to metallizing polymeric films with thin Aluminium coating inside a vacuum web metallizer. Aluminium metallizing can provide good barrier against oxygen, moisture and light. Coating a polymeric film at high vacuum with a thin layer of Aluminium improves the barrier against gases by a factor of 20–200 compared to the uncoated film. Oriented Polypropylene (OPP) and oriented Polyester (PET) films are the major metallized films for snack foods, e.g. chips in pouches; bag-in-box for pumpable fluids; microwave susceptors; roll leaf stamping films; coffee packaging; holograms, and the non-packaging solar energy control films.

Paper is also directly or indirectly metallized with Aluminium for many applications including cigarette packaging, labels giving eye catching lustre, gift wrappings, holograms, candy and chewing gum wrapping, butter and fast food wrappings. However, recent market demands for more robust and durable coatings for a variety of new applications have encouraged developments and investments into new vacuum coating processes that can be retrofit inside standard Aluminium web metallizer instead of investing in purchasing specialised metallizers for a particular product.

This article will describe some of the new capabilities that can be offered by converted vacuum web metallizers to meet the demands of different markets.

What is vacuum web metallizing?

Vacuum web metallizing is a batch process in which a substrate is coated with some materials inside a vacuum chamber. After loading a roll of polymeric film, or paper, onto the unwind zone of the vacuum chamber, the vacuum chamber is closed and then automatically pumped down to the correct metallizing pressure (typically 5 x 10^{-4} mbar). In this period the evaporators are heated up to an operating temperature of 1500 °C (2732 °F) and the Aluminium wire is fed onto individual resistance heated intermetallic evaporators where it melts and evaporates. During the initial operations, the stationary polymeric film (or paper) on the chilled drum is protected from the heat of the evaporators by a movable shutter. When the correct evaporation conditions are reached the film is accelerated to a speed of up to 840 m/min (2756 fpm) and then the shutter is opened, exposing the film to the Aluminium vapour. At the end of the roll, the machine automatically decelerates and the evaporators are cooled down. The chamber is then vented to air and can be opened and re-loaded with a new roll of film. The deposited Aluminium layer is approximately 300–400 Angstrom thick (30–40 nm). Output, reliability, downtime, product quality and running cost are critical factors in achieving an efficient and profitable metallizing operation. Direct metallized paper and board uses the same process as polymeric film but the paper and/or board is first primed to seal the surface and to give improved smoothness to the surface. The paper and/or board then vacuum metallized and re-moisturized to replace moisture lost in the vacuum chamber. Finally, the paper and/or board post coated with a print receptive lacquer.

Limitations of standard web metallizing

Most vacuum web metallizers supplied worldwide are mainly designed for Aluminium metallization. However, the trend in the market is moving toward the use of other coatings to provide better properties and visual lustre for functional and decorative applications.

There are some new emerging markets in this regard including transparent barrier coating for food packaging and new coatings for holographic applications. At present there is a range of different vacuum coating processes that can be retrofit to standard vacuum web metallizer to produce other coatings besides Aluminium for various applications. This makes standard metallizers more flexible in meeting the new demand in the market. Some of these coatings will be outlined as follows:

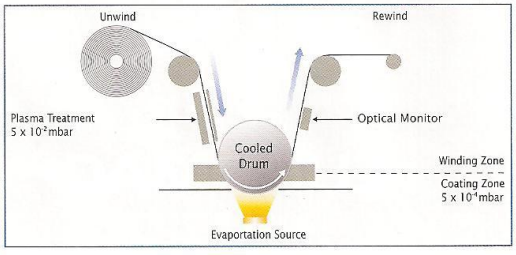


***Figure 1:* Aluminium evaporation process.**

Idvac Ltd, Manchester/GB, www.idvac.co.uk

Clear barrier for food packaging

This includes Silicon oxide and Aluminium oxide. These coatings are transparent and provide oxygen and water barrier. The coatings are available in the market. However, new techniques have been developed to convert standard Aluminium metallizers to provide such coatings. Some applications include microwaveable snacks, lidding of fresh foods, ready meals, moisture sensitive confectionary and medical packaging. Typical barrier provided by such clear coatings is:

- Oxygen barrier: <4 cc/m²/day at 23 °C (73.4 °F); 50% RH.
- Water vapour barrier: <3 g/m²/day at 38 oC (100.4 °F) and 90% RH.

Holographic market

New coatings with unique properties have been developed for the holographic market to fight counterfeiting and to provide functional and decorative properties to the hologram. A range of such coatings will be outlined:

High refractive index (HRI) coatings

These are used as see-through coatings on holograms for security documents such as passports, driving licence, identity cards, etc. The coatings offer about 30–40% reflection with 60–70% transmission and minimum absorption. The most common coating is Zinc Sulphide (ZnS). However, Zinc Sulphide is a soft coating and has to be protected with a top coat to make it durable against moisture. On the other hand, Titanium Oxide is another HRI coating which is scratch resistant and more durable than ZnS against moisture. *Table 1* shows the typical process parameters for coating PET film with ZnS or Titanium Oxide inside a standard web metalliser for holographic applications.

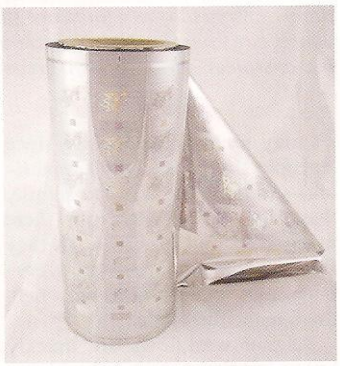
Copper and Copper alloy

Holographic embossed films metallised by Copper or Copper alloy exhibit an aesthetically appealing Copper or deep gold lustre. There are two main reasons for the introduction of Copper metallisation as an alternative to standard silvery coloured Aluminium; the first is the bright lustre of the Copper, which is difficult to be replicated by using standard Aluminium metallizing with chemical pigments or dyes, and the second is the de-metallizing of Copper, which is somewhat harder than the de-metallizing of Aluminium. In the de-metallizing process the metal is removed by chemical or physical process to print letters, logos or patterns within the metallised side. De-metallizing adds another feature to the security hologram to fight counterfeiting. The other added advantage is the electrical conductivity of Copper, which could be used for other applications such as RFID antenna.

Holographic film metallized with Copper.

Chrome alloy

Chrome alloy coating has been developed as an alternative to metallized Aluminium to increase the durability against moisture and salty environment. As an example, metallized Aluminium can not be used on outdoor holograms such as those used on a car number plate or road signs. However, Chrome alloy is durable and can be used on outdoor holograms or other applications, in which the hologram is exposed to a high level of humidity and salty environment. The Chrome alloy coating has a high reflectance as compared to sputtered Chrome, good durability and can be applied at a line speed of 120–150 m/min (394–492 fpm) compared to a line speed of a couple of meters per minute for standard sputtered chrome. When testing Chrome alloy in a salty humid environment, results show that Chrome alloy coating provides very good protection to an environmentally sensitive coating in comparison with metallized Aluminium or Aluminium coated with SiO_x coating.



Holographic film metallized with Chrome alloy.

Conclusions

Continuous investigation of advanced materials has resulted in the development of many coatings that can be metallised inside a standard vacuum web metalliser. Such coatings are used to provide good barrier for packaging and to produce holograms with unique features for functional applications and to fight counterfeiting. ■

Table 1:
Typical deposition parameters of Zinc sulphide and Titanium oxide.

**** Depending on base lacquer used and quality of PET Film.***

Process parameters	Zinc sulphide	Titanium oxide
Type of film	12–50 micron PET	12–50 micron PET
Web width	600–1600 mm (23.6"–63")	600–1600 mm (23.6"–63")
Line speed	200 m/min* (656 fpm)	60–80 m/min* (197–263 fpm)
Coating thickness	450–500 Å	350–450 Å
Coating uniformity	± 5%	± 5%
Absorption	< 2.8%	<3%
Reflectance	30–40%	30–40%
Colour	Transparent	Transparent
Refractive index	2.3	2.3