The metallic effect of packaging attracts attention and seduces many consumers, especially in the fields of perfumery, cosmetics or spirits. This luxurious aspect is in great demand and is the subject of much research and development.

To achieve this level of surface reflection and metallic effect is a real challenge for printers and ink manufacturers. Depending on ink technology, printing process, and technical constraints, the results are not always what we expect. Several methods make it possible to get this rendering through the use of metallic pastes or inks, metallized substrates or through effect pigments. We took stock of the different possibilities that can be considered in print workshop.

1- Metallized paper, PET, metallic sheet

The metallic coating of the paper or polyester film is obtained by evaporation of an aluminum powder, at high temperature, under vacuum. The aluminum vapor layer is deposited directly on the paper or on a PET film which will then be laminated on cardboard. The metallic aspect is convincing. Thanks to its high reflective surface, PET cardboard is often used in luxury packaging. Among all the current alternatives, it is the brightest, with a metallic sparkle unequalled. This metallic appearance can be «colored» by applying a colored ink film on the surface. Thus, a colored metallic effect can be simulated, on all or just a part of the design. A yellow color «Pantone 121C» for example, can be printed on metallized paper, PET metallized or on metal sheet (canning, cans, capsules...), for a guaranteed gilding effect.

If you want a metallic effect only on a part of the design, such as a logo for example, it will be necessary to add an opaque white under the other parts in order to cover and hide the metallic reflection of the substrate.

The metallic luster of the PET cardboard was compared to 4 other solutions, also used in the offset and narrow web market: an offset silver metallic ink, an UV flexo silver, a metal plate, and an aluminum foil.

All these cases were measured with a spherical spectrophotometer. Thanks to the spectral curves that indicate the amount of received energy over a given wavelength range, we are able to evaluate the light reflection of each application. A paper «White» was selected as reference, because the white has the ability to fully reflect the incident light. From the spectral curves shown below, we confirm our visual assessment. Among the 5 types of applications, the metallized PET cardboard is obviously the most reflective. It returns almost the same amount of energy as a white paper. Its mirror effect is unmatched.

However, manufacturers are more and more sensitized by the environmental impact of their packaging at the end-of-life stage. The recycling issue is at the heart of all ecological debates at the moment and the metallized PET board is very complicated to recycle. This involves a 1st phase separation of PET film and cardboard, and a 2nd phase separation of aluminum and PET. This step is technically impossible to achieve, compromising the final quality of recycling. That’s why alternatives of metallized PET are actively researched.
2- Metallic pastes and inks

Another method to bring the metallized appearance to a printed packaging is to blend metal paste directly into the ink mixture. This paste is made of gold or silver effect pigments. These rare and expensive metals are obviously replaced by powders of bronze (in the case of gold) and aluminum (for silver). 3 elements are necessary for the preparation of metal pigments: a metal (aluminum, bronze or copper), a solvent and fatty acid (oleic acid or stearic acid) to prevent agglomeration of particles. After mixing and filtration, we obtain a pigment paste, the particle content of which is of the order of 70%. The size of the particles is variable, depending on the duration of the mixing/grinding operation.

By mixing the metal paste with a varnish, we obtain a metallic ink, ready to be used. The silver inks are reconstituted on a base of 70% of varnish and 30% of metallic paste whereas the Gold is reconstituted with 50/50 (varnish/gold paste).

Metallic inks are not limited to gold or silver effects. The metal base can be incorporated into a colored ink mixture. Pantone® references more than 600 colors, through 2 color guides dedicated to metallic inks. All colors are made from 8 metal bases (Gold, bronze, silver: P871 to P877) + color: The specific «Premium metallic» color guide offers fresher and brighter colors, formulated from a silver which is more shiny: P10077. These specific color matchings are done in the laboratory, case by case. Metallic pigments having very different behaviors, from one mixture to another, the results are not predictable.

The manufacture of metallic inks is a real challenge. The use of aluminum powders is quite complex. When coating the pigments, they may interact with the binder and cause chemical or physical reactions. The chemical reactions can induce a caking: the viscosity of the ink increases, hindering any printing. On the other hand, the metal particles have a higher density than the binder, and after a while, these particles fall down and sediment. Then, it is necessary to exert a considerable force to re-homogenize the mixture. These issues affect all ink technologies, and even more the INKJET inks. Due to their ultra-liquid environment, and the need to use very fine particles, these factors may involve polymerization reactions. A low viscosity is essential in INKJET. If the viscosity is too high, the ink may clog the injection heads. This is a real constraint for the manufacture of metallic inks.

3- Miror inks type Metalure®

As for metallized PET, aluminum powder is evaporated at high temperature and deposited on a given substrate, then scraped off, before being integrated in the mixture to develop the metallic paste. The prior evaporation phase provides an additional metallic luster. The effect is surprising ... the price too! This solution is quite expensive.

*the gold powder was actually bronze powder: a copper-zinc-aluminum alloy. The proportions of the constituents varied according to the desired color.

4- Bronzing machine

The bronzing process was a frequently used process in the past. Metallic powder, gold* or silver, was projected on a substrate which was previously made adhesive in certain areas thanks to the deposit of a varnish with high tack level. The powder was fixed at these locations, the excess was removed by a wiping system. In the past, this technique was particularly used for the manufacture of wine or champagne labels. The gloss and sparkle obtained were spectacular and differed markedly from a metallic ink printing. Unfortunately for the results this process has practically disappeared because of the toxic inhalations of the powder by the operators.

*A copper-zinc-aluminum alloy. The proportions of the constituents varied according to the desired color.
5- Hot stamping

The hot stamping is one of the most upscale finishes, which consists of marking a product by transferring a metal film to a pre-printed design. Printers have been using it for several decades to embellish various types of work such as business cards, wine labels, tickets or cases, for example.

A metal film is transferred by pressure and heated with a print form or a magnesium plate on a pre-printed or colored paper. The temperature can vary from 60 to 200°C.

The gilding film is placed between the material to be embellished and the previously heated plate. When the plate comes into contact with the film, under the hot-cold contrast effect, the sheet breaks; Only the cliché shape remains and appears on the printed board.

In addition to the Gold and Silver, the hot foil offers a wide variety of colors, gloss, satin or matte, ranging from blue to red, through green, orange or violet.

A metal film is transferred by pressure and heated with a print form or a magnesium plate on a pre-printed or colored paper. The temperature can vary from 60 to 200°C.

No other printing system (offset or digital) can give this real gold or silver effect (not even silkscreen).

6- Coldfoil

Unlike hot stamping, coldfoil doesn’t require any plate or cutting shapes. Only the right amount of transfer films is used according to the area to be decorated. Some presses can be equipped with systems such as the InLine Foiler (Man Roland 700), in order to beautify the packaging directly online proofing. With 6 groups, these presses can treat coldfoil as a fifth color.

From the technical side, a glue is applied on a 1st group in order to fix the transfer film which will pass onto the next group.

The technique is a real asset from an ecological point of view because it allows to deposit the gilding in a specific area without waste.

Moreover, it is possible to overprint a color on the cold gilding, as one can see in the example.

So many advantages that make coldfoil a very economical and highly competitive solution for a spectacular result.
Optical properties of metal inks

The metallic effect of an ink is largely influenced by the orientation of the particles in the ink film. The leafing* phenomenon is partly responsible for the «mirror» reflection.

Several factors will have a determining role on the particles’ orientation in the ink film: The resin or the solvent surface tension (which is closely related to the ink viscosity), and the drying time. Thus, the higher the surface tension of the vehicle or the solvent mixtures, the more important the leafing phenomenon. This is the case for water-based inks. The water has a high surface tension which keeps the metal particles on the surface during the evaporation phase.

To provide an iridescent effect to the printed package, it is advised to use nacres (Mica flakes coated with Titanium dioxide TiO2 or iron oxide Fe2O3 for example) mixed with an overprint varnish. Sometimes, they are applied over a metallic ink to strengthen its metallic sparkle.

Ink film cuts illustrating the phenomenon of leafing (left) and non-leafing (right)

Liquid metallic inks (water-based flexo, solvent-based/gravure) are favored by their low viscosity and benefit from a surprising surface reflection. The average size of metal particles also affects the printed product transparency and gloss. The finer the particles, the more opaque, covering and pearly the film. For a very bright effect, it is advisable to use larger particles, which favor the reflection. Unfortunately, printing problems generally associated with metallic inks tend to increase with larger particles’ size or by increasing pigment concentration. Therefore, it can be difficult to obtain the desired metal effect, depending on the ink technologies or the printing processes.

In offset for example, the printing process induces a very low ink deposit, which requires finer particle sizes, therefore more covering and less glossy. On the other hand, the high viscosity of the offset inks is not favorable to the leafing effect. All these elements together make it impossible in offset to obtain a metal aspect as shimmering as in flexography or gravure. All these elements together make it impossible to obtain a metal aspect as shimmering as in flexography or gravure. In UV offset, another constraint is added: the drying time, extremely fast. The metal particles do not have time to rise to the ink film surface before this is dry. They are blocked to heart, limiting the metallic effect too.

Leafing*: pigments ability to align at the ink film surface, like a well-stacked flakes, in opposite with colored pigments, which are non-leafing: well scattered and undirected in the ink film.

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<tr>
<th>Ink film</th>
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Metallic sparkle level achieved depending on the conditions
favorable condition: 😊 not favorable: 😞

Did you know?

How is mother-of-pearl formed in seashells?

The mother-of-pearl of some mollusk shells has long been sought after for decoration, inlay and jewelry, to the extent that some shells such as abalone have locally disappeared. Mother-of-pearl comes from a natural organic phenomenon. It is composed of aragonite-calcium and carbon crystals, juxtaposed in regular layers. The appearance of mother-of-pearl doesn’t come from pigments; it is the superposition of different refractive indices layers, that create interferences. The perceived color depends on the light incidence angle and the observer’s position. Thus characteristic iridescences are revealed.

The iridescent nacre inside a nautilus shell

The iridescent nacre inside a nautilus shell
Colorimetry for metallized inks and substrates:

The colorimetric measurement of highly reflective or shimmering surfaces is very difficult. Whether for metal inks or metallized media measurement, very specific instruments are required. The traditional instrument, 45/0 ° geometry which is very powerful on cardboard supports, absorbent paper, must be avoided for measurements on polished or ultra-reflective surfaces, like a mirror. In those conditions, this type of instrument is almost «blind», because nearly 100% of the emitted rays will be reflected in the opposite direction, and consequently, no light will be measured by the sensor (Fig. 1). It is falsely interpreted as obscurity by the instrument. In this case, it would tend to generate wrong values which indicate that the sample is darker than it actually is.

A spherical instrument (D/8 ° diffuse light) can provide more realistic measurements for such applications. The light source is emitted into the sphere, which has a highly reflective white coating. Thus, light rays are reflected from all angles. (Fig.2). Light is diffused throughout the sphere, allowing the sensor to capture a sufficient amount of light, for a result closer to human vision. These instruments are available at X-Rite or Konica Minolta, and generally may be associated with software to perform quality control or color development.

There is also another type of instrument, less frequently used in the graphic arts, but more particularly in the field of automobile paints: the multi-angle (MA).

MA is especially designed for color measurement of metallic or effect paints, such as pearlescent coatings, which can exhibit a noticeable visual change from specific angles of view.

Thanks to these multiple angles of measurement (6 to 11, depending on the supplier & model), this type of instrument is able to evaluate the color accuracy of special paints and coatings among others, as perceived by the human eye, as if you were twisting the sample to control, in order to visualize the color from several angles. (Fig.3). Some spectros can be connected to specific QC software but there is no chance to be helped with a formulation software with this kind of instrument.

For this type of application (inks or metallized substrates), the slightest variation of the printed object’s inclination changes the colored reflection. It is very difficult to reach the target color at any inclination angle. The spherical spectrophotometer is the preferred instrument in this field. Even if the results are not optimal in formulation, it allows to approach the target color and provides crucial assistance to the colorist for these specific color developments. Nevertheless, for these jobs, our eye will judge the best compromise according to the differences observed under the different angles of observation. Measuring instruments are equipped with state-of-the-art technologies and are constantly evolving. The next generations will undoubtedly be more accurate in the metallic field.