# 2010
# Article 4

## Glass and Ceramics Decoration

In the UK we have a history of applying images to all types of glass and ceramic surfaces mainly centred around Stoke on Trent where all elements of the techniques have been developed and refined. Sadly only a nucleus remains, most having been exported to cheap labour markets in the Far East along with it the technology and supply chain. The rush to sell the family silver is slowing in industries on which we built our industrial prowess because it is nearly all gone. Signs are not encouraging with the emerging technologies as these are developed in the UK and shipped abroad. If this continues we will be little more than an industrial and cultural museum for the manufacturers of the Far East.

Whether you are decorating glass or ceramic the printing techniques used are very similar all aim to achieve the adhesion of pigment to the surface and have that pigment maintains its colour or performance over the required time period. No different to any other application but the operating conditions of printed glass and ceramics can be extremely challenging. In graphic applications mechanical abrasion is one aspect and resistance to chemicals is another.

The favoured technique for many years has been to use pigments that are fused to the surface at high temperatures. These pigments were inorganic. As the environmental impact of the process and the pigments make them fall out of favour organic pigments that are stuck onto the surface are becoming more popular.

Starting from the point that pigment is the part of the ink that gives the colour, what is the difference?

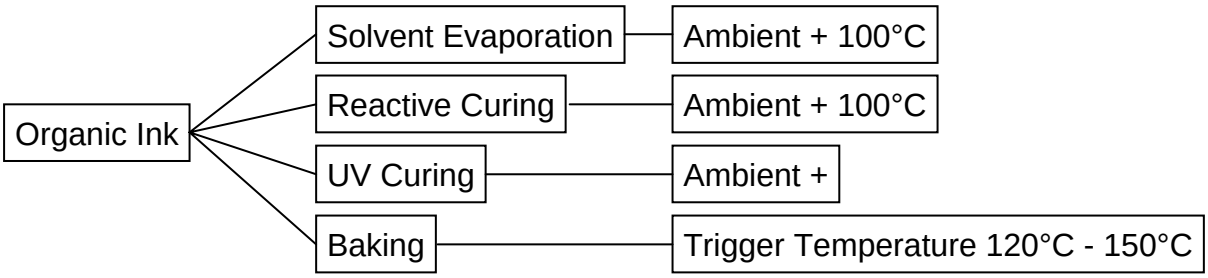
Inorganic pigments are derived from mineral compounds. They are normally oxides or salts of one or more metals. They are resistant to temperature, sunlight, chemical and mechanical attack. Their downside is that they used to be made from Lead, Cadmium, Chrome and other heavy metals along with Zinc, Tin etc. This means they potentially present a health and environmental hazard. Some still are used but the heavy metals of cadmium, chrome and lead have been substituted with much safer materials Inorganic pigments cannot be dissolved in conventional solvents.

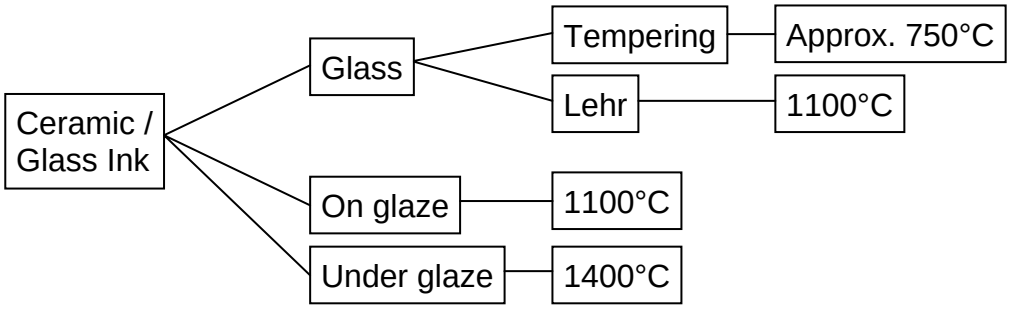
Organic pigments come from plants either in their natural state or when they have been converted into oil and its derivatives. The pigments all contain Carbon which means an almost limitless range of colours can be formulated, these colours can be very vibrant even fluorescent. What organic pigments are very poor at providing is metallic colour unlike inorganic pigments that can be a suspension of metal flakes, silver, gold, platinum, aluminium etc.

Organic pigments will normally be formulated into inks that consist of resins and solvents or in the case of Ultra Violet systems without solvents.

Inorganic inks or enamels are a mixture of glass particles (frit) pigment, solvents, waxes or oils and additives.

It is possible to use metallics pigments in organic resins and the effects can be close to enamels but the mirror finishes are only possible in specialist applications where the metallic ink is printed on the back of a high gloss plastic sheet. This is not suitable for printing onto glass or ceramic. If you want true metallics on glass or ceramic you will have to use inorganic enamel (ink/colour.)

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As well as the types of inks shown above; when using inorganic inks/enamels there is an option of using what is known as Thermoplastic Ink. This is an ink system that at ambient temperatures is a wax like solid. When the temperature is increased to 65-70 oC (sometimes higher) the wax liquefies and depending on its composition and temperature will have a viscosity between 800 and 2000 Cp. Thermoplastic ink is particularly useful when printing multi-colours as when the warm ink contacts the cold ceramic or glass it hardens quickly so a second or more colours can be overprinted.

The normal method of heating the ink is to first pre-melt it and pour it onto a stencil that is made from steel mesh. The mesh has a controlled electric current passed through it so that it heats up and maintains the ink in a fluid printing state. The system is so

efficient that it is possible to print multiple colours on glass bottles at rates up to 7000 per hour.

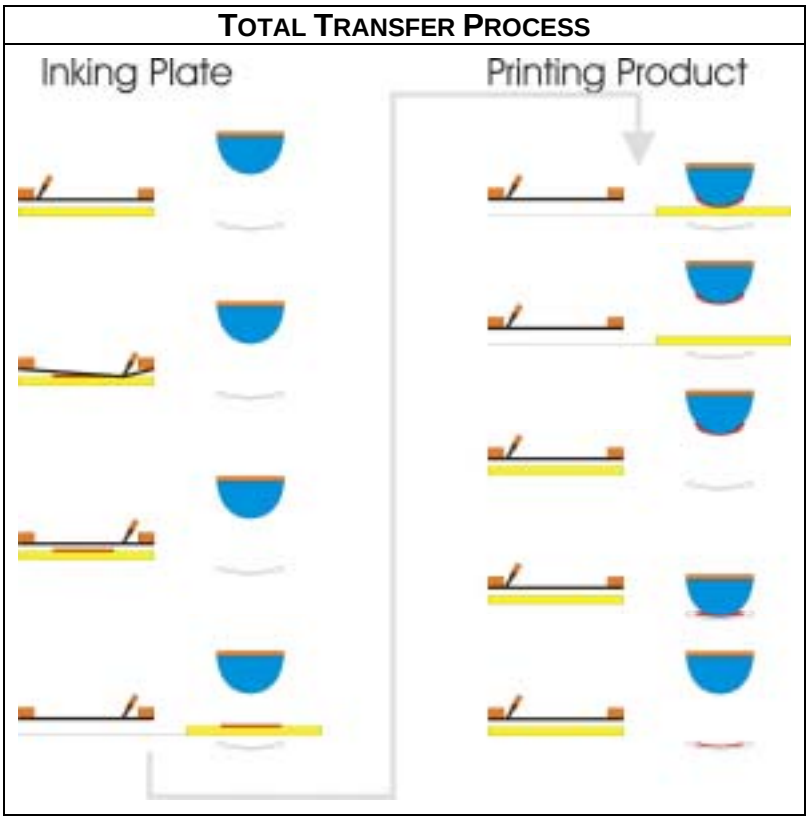
This method is also used on ceramics. In both cases the printed item has to pass through a lehr in the case of glass or a kiln if it is ceramic. Both a lehr and a kiln must be very carefully controlled regarding speed (with a lehr,) temperature profile and internal atmosphere, otherwise colours will change and images distort.

The use of enamels that are either thermoplastic or liquid can use a great deal of gas or electrical energy. Alternatives are required and these take the form of organic pigment based inks that are not fused by glass frit onto the surface of the glass or ceramic or under the glaze. Organic pigments would not withstand the temperatures to melt the glass frit in the ink.

The alternatives are reactive inks that use a catalyst to achieve a hard chemical resistant surface, baking inks that need elevated temperatures 120 to 150 oC that trigger a chemical reaction or Ultra Violet Curing Ink systems. The latter ink type is gaining a considerable foothold in glass decoration. Instant UV curing means that multi-colours are possible and adhesion along with chemical resistance is such that items printed with this system will withstand dishwashing many times over. Bottles, glasses and other glass object are now printed this way but it will not give you the mirror gloss metallics achievable with inorganic metallic pigments.

When printing directly onto glass and ceramics screen printing and pad printing can be used and there is a combination of both processes called “Total Transfer” this is where the image is screen printed onto a flat plate and then picked off by a silicone pad and transferred to the article. This process allows thick films of ink to be applied to uneven objects. Pad printing with heated plates works very well but there are pros and cons for both systems. Four colour process is possible with inorganic Cyan, Magenta, Process Yellow and Process Black.

**TOTAL TRANSFER PROCESS**



This is not for the inexperienced as colours can easily change in the printing and firing process. You don't have the benefit of colour bars, greyscales or density measurement as the printed colours change during the firing process and you can't guillotine off the colour bars.

The simpler alternative to direct printing with ceramic colour is to produce waterslide or heat applied transfers. These transfers are produced by screen printing and lithographic printing. Waterslide use water soluble glue that allows the image to lift off special paper before being positioned on the substrate. Heat applied transfers come off the carrier paper or film when applied with a heated blanket to the substrate. In both cases the applied image has to be fired at elevated temperatures.

Royal Crown Derby is at the pinnacle of waterslide transfer decoration. Their screen printing facility maintains the skills evolved over many years to produce transfers used on their fine bone china products.

Thousands of different designs using inorganic pigments and precious metals can be stored and recalled from a massive database for the screen printing department to meet the exacting quality of collectors around the world.

With its beginnings before 1750 Royal Crown Derby the company has demonstrated its durability by consistently producing top quality table ware, giftware and collectables on their current site since 1890. This is an excellent example of where a British private limited company has moved with times to continuously develop a top quality product that it sells worldwide.

In a more mundane but large scale screen printing application, automotive glass, relies on screen printing for heated windscreens and styling features. Then of course there is architectural glass that is increasing in popularity.

**TRANSFER APPLICATION AT ROYAL CROWN DERBY**

Courtesy Richard Dennis

**METICULOUS PROCESS CONTROL AT ROYAL CROWN DERBY**

Courtesy Richard Dennis

None of these methods should be confused with sublimation transfers that appear to print onto ceramics and glass but are in fact producing an image in a polyester lacquer that has been sprayed or dip coated on to the ceramic. Although very attractive this is not as resistant as fired enamels or even UV

cured inks. Sublimation inks are not particularly colour safe in sunlight or elevated temperatures but it is still a big market particularly in personalisation and business gifts.

Digital printing is used in this area and there are some ceramic applications where it works well. Direct tile printing and the production of transfers are two but low speed is always a drawback on long runs.

In summary the options are:

Inorganic ink that can be screen printed or pad printed but requires a kiln or lehr to fuse the enamel to the surface.

Organic ink that can be screen printed or pad printed that is a UV curing system or requires temperatures up to 180oC for a period of time.

Heat applied or waterslide transfers printed with inorganic ink that have to be fired in a kiln or lehr.

Sublimation systems.

If you don't have the kiln or lehr as a screen printer the production of transfers can be a very good business and there are still some very able printing companies making an excellent living from this market. As the globalisation business model demonstrates its shortcomings such opportunities are increasing. Maybe just maybe the Made in Britain stamp will start to re-emerge not just in Museums!