EASTMAN

Technical tip

Using Eastman SAIB 100 in ceramic coatings

Introduction

This technical tip explains the benefits of Eastman SAIB in ceramic coating formulations for curved ceramic or glass objects such as plates, cups, and bottles. The process of printing such objects is generally carried out by the total transfer printing process, and this technique is also outlined in this technical tip.

The benefits of Eastman SAIB 100 for the total transfer printing process

The ceramic inks used in the process are a mixture of pigments (metal oxides and salts) and finely ground glass particles called "frit" suspended in a media. The media is composed of solvent, SAIB, and a resin. The inks are fused to the substrate by calcining ("firing") them at temperatures between 600°–1450°C. Firing temperatures vary depending on the make up of the color, the nature of the substrate, and other application criteria, but in all cases, the temperatures must be carefully controlled to achieve specific colors after firing. During firing the media must be completely burned off leaving behind a glazed surface.

The advantages of Eastman SAIB 100 in the ceramic ink media are as follows:

- Ability to reduce in viscosity at both elevated temperature and increased shear rate, allows good print transfer through the printing screen.
- A very unique feature of SAIB containing ink is that after printing at an elevated temperature, the viscosity of the ink increases dramatically allowing good print definition and often allowing printed articles such as plates to be handled without smudging.
- The pigmented base coat has enough redissolve resistance to apply the final glazed top coat without merging into the base coat.
- On firing, SAIB is completely burned out at relatively low temperatures leaving behind a high quality glazed article.
- SAIB can be used in both colored and also gold inks. In the case of gold inks, a very low film thickness (100 nanometers) can be produced with a sharp gold print with excellent brilliance.

What is the total transfer printing process?

- The total transfer printing process is outlined in Figure 1.
- This process involves a screen which contains a photographic image produced by creating nonimage and image areas. The image areas of the screen allow ink to pass through them and print the image, and the nonimage areas are not printed.
- A squeegee pushes the ink through the screen.
- The screen and ink are heated to approximately 80°C to lower the viscosity of the ink.
- Eastman SAIB as a component of the ink formulation produces a very large reduction in viscosity when heated (Figure 2). This helps the ink pass through the screen, producing a sharp print definition.
- The ink is printed from the screen onto a flat silicon rubber substrate that is warmed to approximately 45°C. At 45°C the SAIB containing ink is a lot higher in viscosity than it was at 80°C. This increase in viscosity produces more tack and consequently aids transfer of the printed image onto the silicon rubber substrate.
- The image is now contained on the flat silicon rubber.
- The image needs to be transferred to curved plates or cups. To do this, a dome-shaped silicon rubber mold at ambient temperature is pressed flat onto the image on the flat silicon rubber. The ink that is transferred to the dome rubber mold cools and is now at a much higher viscosity required to create the right conditions for transfer to the silicone dome.
- The silicon dome now contains the image.
- The image on the silicon dome is printed smoothly onto a curved ceramic plate or cup.
- There are identical banks of these systems so different colors can be applied.
- The printed image should now be high enough in viscosity to allow light handle ability without smudging.
- Protection of the pigmented ink is critical, so a clear layer of ceramic glaze is then applied to protect the image.
- The ceramic article is then heated to 500°–1200°C to remove the media (resins/SAIB/solvents). It is important that the media burns off cleanly. Many resin systems do not burn off cleanly. The resins/SAIB/solvents generally burn off at 350°–400°C (Figure 3).
- The high quality glazes have fusion temps as high as 1400°C. However, many pigments are not stable at 1400°C and often the print underneath the lacquer loses some depth of color.

Typical colored ink composition

- Eastman SAIB 100 is generally used in all the different colors of the pigmented colored base coats.
- The formulation of the ceramic ink is generally two parts of pigment to one part of media. The ink also contains some fluxes and 15-mm glass carrier. More pigment is often used when good depth of color is required.
- The media is typically composed of 70%–80% SAIB: 20%–30% of a hydrocarbon resin (contact your Eastman representative for details of the best types of hydrocarbon resins for these applications).

Figure 1.
Total color transfer printing process for ceramic inks

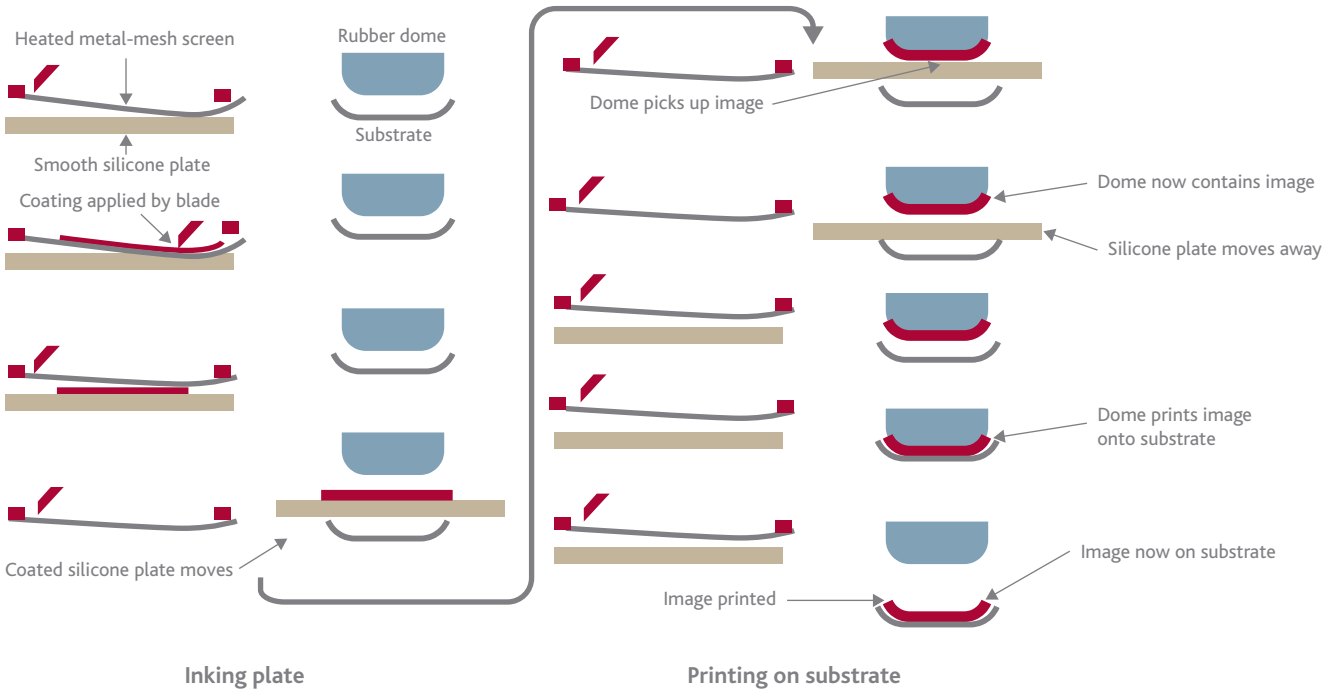


Figure 2.
Influence of temperature on viscosity reduction of Eastman SAIB 100

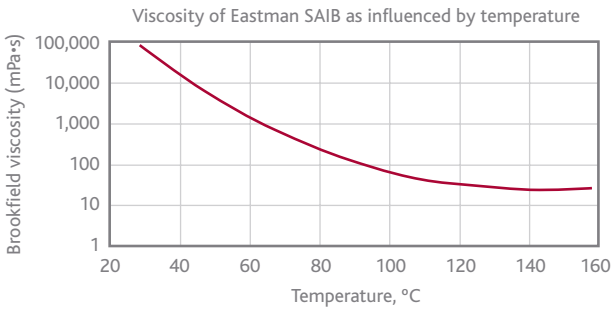
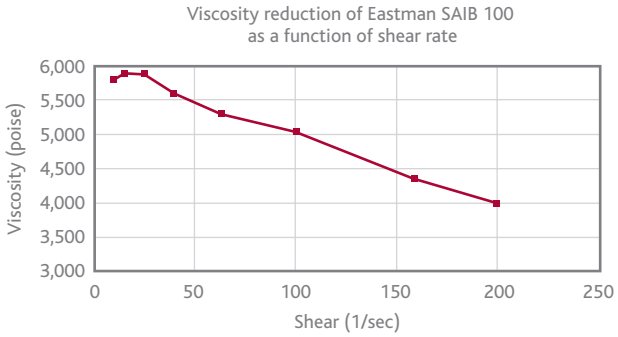


Figure 3.
Influence of shear rate on the viscosity at 30°C of Eastman SAIB 100



Rapid viscosity reduction of Eastman SAIB 100 with temperature

An unusual property of Eastman SAIB is its abrupt change in viscosity with temperature variation or with the addition of solvents. For example, SAIB has a viscosity of about 100,000 cP (mPa•s) at 30°C. An increase in temperature of only 20°C reduces the viscosity to approximately 8,000 cP (mPa•s) as shown in Figure 2.

Fast viscosity reduction of SAIB 100 as a function of shear rate

The type of rheology produced by Eastman SAIB 100 was investigated utilizing a typical screen-printing shear rate range of 0 to 200 sec-1 at a temperature of 30°C.

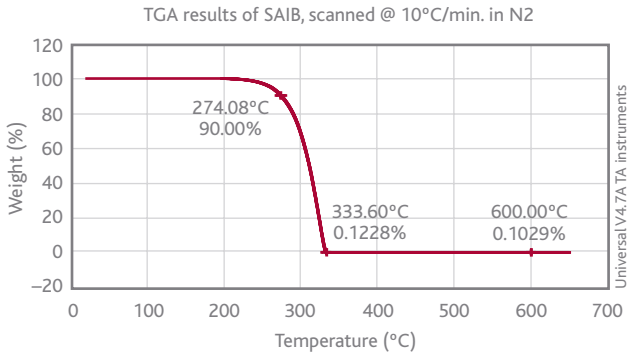
- The rheology produced was such that Eastman SAIB 100 reduced in viscosity when a shear force was applied to it.
- This shear thinning is ideal for printing processes where a low viscosity is required for printing through the screens of the total transfer printing process. This type of rheology enables a very good print definition to be produced which creates a very sharp printed image. This is very important when printing the fine detail required on ceramic and glass objects.

Excellent "burn out" properties of Eastman SAIB 100, Thermo Gravimetric Analysis.

Figure 4 shows the residual amount of weight % retained of Eastman SAIB 100 after thermo gravimetric analysis burn out in nitrogen at 600°C.

- The graph shows that there has been very good burn out of the SAIB such that at 333°C there is virtually no SAIB present.

Figure 4.
Thermo Gravimetric Analysis of Eastman SAIB 100 (ambient to 600°C)



Conclusion

Eastman SAIB 100 should be considered as an important formulation tool in the ceramic ink formulations used in the total transfer printing process. Eastman SAIB 100 provides a unique ink rheology at both elevated temperatures and increased shear rates, allowing for good print definition. At lower temperatures, the viscosity of the ink increases sharply allowing handle ability such that the printed ink base coat has enough redissolve resistance to apply the final glazed topcoat without smudging the base coat. After heating (firing) of the glazed article, SAIB is completely "burned off" to produce high quality printed images on articles such as ceramic plates or cups.

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