Colorants for Digital Printing: A Challenge for Development

Ulrike Rohr, Rüdiger Baur and Hans-Tobias Macholdt
Clariant GmbH
Frankfurt, Germany

Abstract

Electrophotography and ink jet are the most important NIP (non-impact printing) technologies in digital printing. Colorants for electrophotographic systems have to fulfill special requirements which can be very different compared with colorants used in conventional printing inks and which can also differ for each toner type. Ink jet inks are much closer to traditional printing inks, but still there are many important differences. The presentation will discuss the challenges in the development of pigments and pigment preparations for electrophotography and ink jet applications.

"Inks" for Electrophotography: Toners

In electrophotography the "ink" is called toner. There are solid toners as well as liquid toners. In liquid toners colorant particles (pigments), resin, charge control agents and additives are dispersed in a dielectric liquid and the resulting colored toner particles are electrophoretically transferred to the latent image. Solid (or powder) toners can be produced in a "physical" process, which means that the ingredients are physically mixed or in "chemical" processes e.g. suspension polymerization or emulsion aggregation.

Colorants for Digital Printing

Basically there are three types of colorants for digital printing: dyes, pigments and predispersions. Pigments are hard to disperse but show better light fastness when compared to dyes. In electrophotography > 90 % of the colorants are pigments and even in ink jet printing the development of pigmented inks gains in importance. The focus of this paper will be on pigments.

Pigments can be provided as pigment powders, pigment presscakes or in the form of (solid or liquid) predispersions. Table 1 points out the most important properties that have to be taken into account when selecting a pigment for digital printing, and that are different to traditional printing requirements. For example, the measurement of the influence on triboelectric charging for a pigment is unique for electrophotographic application; also tribo behavior is different depending on the pigment class. [1]

Table 1. Requirements for Pigments in Digital Printing

PIGMENTS	Electrophotography	Ink jet
coloristic	higher transparency = smaller particles: d_{50} < 150 nm	very small particles: d_{50} < 150 nm
fastness	temperature; no bleed in rubber/resins; no sublimation	thermal: up to 300 °C for thermal ink jet
technical	few by-products	high purity: low salts, few by-products
	dispersibility in toner resins or aqueous systems	no particle growth or agglomeration in ink
	electrostatic behavior	
	compatibility with polymerization	compatibility with ink ingredients

Challenges in Pigment Development

For pigments, not only the chemical structure is of important influence but also the physical properties such as particle size, shape or surface properties. This means that different pigments of a specific Colour Index Number[2] behave completely differently especially in the electrophotographic process.[3] Out of thousands of colorants available, only a few are suitable, and for each digital printing process the pigments have to be selected carefully, or new colorants have to be developed.

As already shown in Table 1, the requirements for pigments differ in electrophotography and in ink jet when compared to classical printing. The chemical purity is especially important: salts in pigments create problems in ink jet printheads (corrosion) and also in dispersion stability. In addition organic impurities may cause kogation in thermal ink jet printheads or result in

unfavorable environmental concerns (Ames positive). Therefore pigments for NIP applications have to be purified very carefully. Another prominent difference is the particle size in the final ink or toner, which is much smaller for NIP applications when compared to classical printing inks (ref. poster presentation).

Challenges in Making Pigment Preparations

Not only chemistry and physics of the pigment itself but also the degree of dispersion can influence its performance in toners and ink jet inks. Since color toners have to be highly transparent (due to high layer thickness on paper), the pigments have to be dispersed to a optimum degree. As this means a lot of effort and energy input, many producers of toners or ink jet inks prefer to use predispersions such as HOSTACOPY® pigment preparations.[4] The challenge for development of all pigment dispersions (solid predispersions for toners or liquid pigment preparations for ink jet inks or chemical toners) is to find out the parameters in the dispersion step that give the best dispersion quality for each system.

This includes adjusting dispersion conditions to the toner resin matrix (e.g. the rheological properties) or investigating, for example, the wetting properties of pigments in the medium used. Fig. 1 illustrates that different pigments in the same polyester matrix result in profound differences in rheological properties: a masterbatch with 40 % P. R. 122 is much more viscous than one with P. Y. 180 or P. B. 15:3.

Surface polarities of pigments and liquid media can be calculated from contact angle measurements with different solvents.[6] This information may help in finding the right combinations of pigment and dispersing medium and meet the challenge of making stable pigment preparations with particle sizes below 150 nm that are needed for example for ink jet inks.

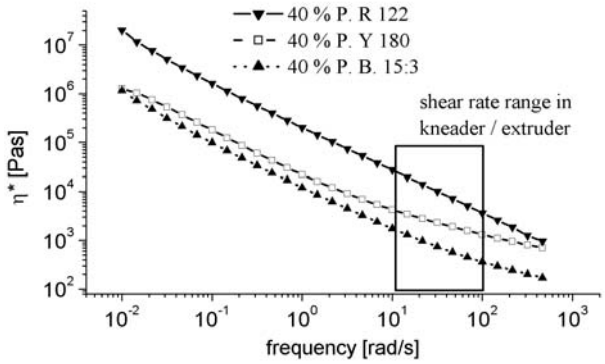

Figure 1. Rheological measurement on pigment preparations: 40 % pigment in toner resin (polyester) (at 155 °C)

Even different requirements have to be fulfilled by pigments which are used for the preparation of so-called chemical toners. In most processes, the pigments have to be finely dispersed in an aqueous medium. A pigment that works perfectly in a physical toner (in a polyester or styrene acrylic medium), does not necessarily work in such an aqueous medium. In addition the colorant has to be inert to the reaction conditions that are applied in the process that forms the toner particles. So again, the pigment surface, form etc. have to be adjusted for such a process.

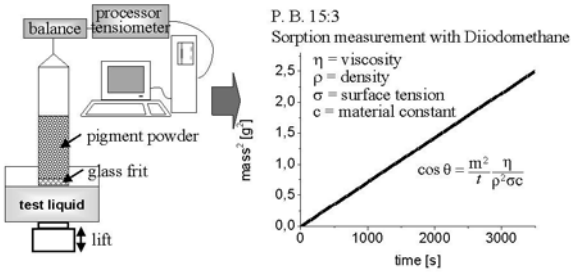

Figure 2. Measurement of surface tension for pigment powders. Owens Wendt[5] theory provides surface polarity parameters.

Finally for the production of liquid toners the pigments have to be easily dispersible in the dielectric medium (e.g. hydrocarbons). This requires different surface properties as well as solvent fastness, which is not so important for the types of applications described earlier.

Conclusion

Due to the special requirements of electrophotography, ink jet and other digital printing processes, there are many challenges to meet in the development of colorants for these techniques. In most cases the use of classical printing ink pigments is not successful. Thorough investigation and adjustment of pigment properties and dispersion conditions help to provide specially designed colorants for digital printing.

References

1. H.-T. Macholdt, A. Sieber, J. Imaging Sci., 14, 89 (1988).
2. The Society of Dyers and Colourists, Colour Index, 3rd ed., Bradford, UK, 1982. The Colour Index describes and lists the different individual pigments in terms of running numbers and combines these numbers with chemical constitution.
3. H.-T. Macholdt, American Ink Maker 70 (10), 60 (1992).
4. Clariant GmbH, "The power behind laser printing performance," Clariant brochure on charge control agents and pigments for electrophotographic toners, 2002 (DP 8519 E).
5. D. K. Owens, R. C: Wendt, J. of Applied Polymer Science, 13, 1741 (1969).
6. a) C. Rulison, Krüss technical note # 213: "Two component surface energy characterization as a predictor of wettability and dispersibility," Krüss USA.
   b) C. Rulison, Krüss TN #302: "Wettability studies for porous solids including powders and fibrous materials," Krüss USA.

Biography

Ulrike Rohr is a member of Market Segment Non-Impact Printing at Clariant GmbH, Division Pigments & Additives. This group deals with research and development of dyes, pigments and charge control agents for NIP applications. Ulrike Rohr is responsible for R&D of pigments and pigment preparations for electrophotography. She holds a Ph. D. in chemistry from Johannes Gutenberg-University, Mainz, Germany. Her doctoral studies were done at Max Planck Institute for Polymer Research, Mainz, Germany.