Organic Pigments For Digital Color Printing

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Abstract

Digital color printing (DCP) is becoming more important versus traditional printing technologies. For electro-graphic-based printers, colored tribo (friction) toner creates the full color image. Typically organic color pigments provide the required color. They have to fulfil both coloristic and electrostatic properties. These properties are the result of the chemical constitution and solid-state characteristics of the pigment. Low electrostatic influence together with high tinctorial strength and appropriate transparency is useful. A new yellow pigment type of the benzimidazolone class combines these aspects. The final electrostatic charge of the toner is achieved by adding suitable charge control agents (CCAs) to control toner charge both in magnitude and sign.

Introduction

In general terms, digital printing means a direct connection of the graphic designing computer with the printing unit. The digital data directly create the image to be printed[1]. Nearly all digital color printers operate on the basis of non-impact printing (NIP)-technologies (e.g. ink jet, electrophotography, magnetography, thermal transfer etc.)[2]. In this group, electrophotographic printers (full color laserprinters and photocopiers, digital color presses) play a key-role.

For developing the digital latent image, electrostatically controlled color toner, often called electronic ink, is necessary[3,4,5]. These color toners typically consist of 90% - 95% resin (polyester, polystyrene acrylic copolymers etc.), 3%-5% colorant, 1%-3% charge control agent (CCA) and other technical additives like waxes.

The color of the toner is attained by incorporating organic color pigments. They are responsible for the color quality of the toner print. Besides their coloring properties, it is well known that pigments can also influence the triboelectric charging behaviour of the toner powder.

Therefore, the coloristic properties and electrostatic properties of organic pigments are of special relevance.

Coloristic Properties

For a full colored document, the colors cyan-magenta-yellow[6,7] are used (CMY-system). Additionally black is often added to get better contrast.

Figure 1 shows various yellow and Figure 2 various magenta (red) organic pigments which are typically in use for digital color printing. For cyan Pigment Blue 15:3 (copper-phthalocyanine) is most widely used.

In general the coloristic properties of an individual pigment describe color appearance after application.

Typical characteristics defining the coloristic properties are: the shade, the tinctorial strength and the transparency (decreasing transparency automatically means increasing hiding power). Also, aspects like lightfastness, thermostability and eco/toxicology have to be covered by a suitable organic pigment for toner use. These aspects are influenced by both chemical constitution and solid state parameters[7] (particle size distribution, particle shape, crystallinity etc.) .

To attain the needed coloristic properties the dispersion behaviour is of special relevance. In general, solid pigment particles are classified in three groups[7]:

1. pigment agglomerates (particle size approx. 0.2-10µm)
2. pigment aggregates (particle size approx. < 1µm)
3. primary pigment particles (particle size approx.<<1µm)

Organic color pigments are typically provided in powder form. The single powder particles usually consist of agglomerates. Agglomerates are groups of small crystals and/or smaller aggregates, joined at their corner and edges. Aggregates consist of primary particles growing together at their surfaces. Primary particles are the smallest pigment particles which ultimately form the crude pigment product. From agglomerates to primary particles the particle size usually decreases.

Dispersion is known as the process of distributing pigments e.g. in a toner resin, by reduction of the particle size and destroying the agglomerates by shear forces. In reality an optimally dispersed pigment consists of both primary particles and aggregates. After the dispersion procedure, the resulting pigment particles should be less than 1 µm and *homogeneously distributed* throughout the application medium.

A higher dispersion quality often goes parallel with increased tinctorial strength, a change in shade, enhanced transparency and viscosity change. To get the optimum dispersion quality, the pigment has to pass four steps during dispersion[7].

1. Wetting	———	pigment wetting by the dispersion medium
2. De-agglomeration	———	particle size reduction
3. Distribution	———	homogeneous distribution of the pigment in the entire medium
4. Stabilization	———	preventing reagglomeration and/or flocculation of the homogeneously dispersed particles

Electrostatic Properties

Previous investigations[10,11] demonstrated that in toner binders, incorporated pigments influence the toner charge depending on the chemical class of the pigment used (Figure 3). Nigrosines and triaminotriphenylmethanes, as well as some cationic dyes, give a significant positive charge. Negative charging was found for metal-salt (laked) azo pigments. Within a pigment class both substituents and solid state properties shift the toner charge in magnitude and sometimes in sign.

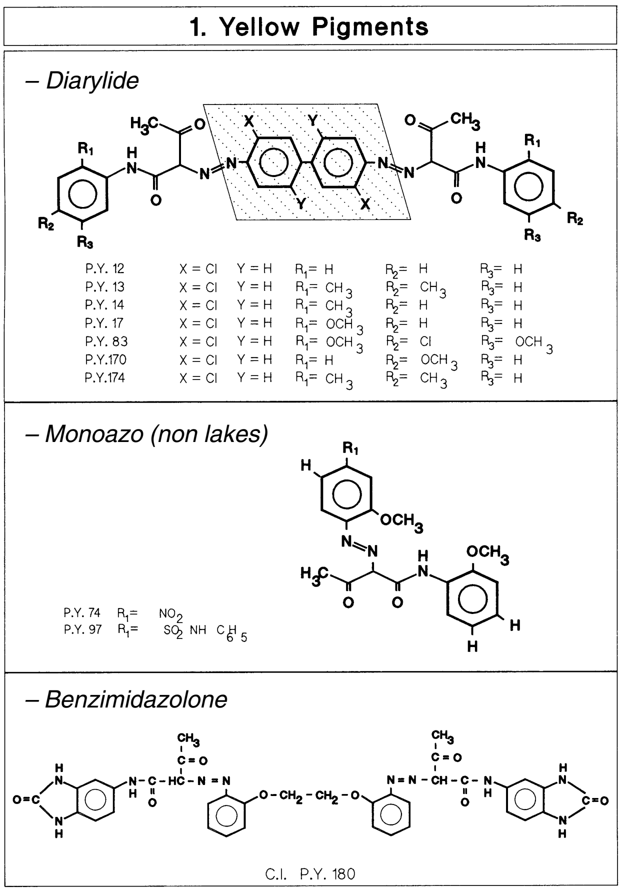


Figure 1. Typical yellow pigments in use for digital color printing. The major ones are dichlorobenzidine-based diarylides which have partly the disadvantage of low thermostability[9]. Benzimidazolone pigments offer special advantages in terms of high thermostability, excellent lightfastness, good dispersibility and high tinctorial strength. Therefore they are increasingly used for toner application.

Typical pigments in use (Figures 1 and 2) for digital color printing like azo pigments or quinacridones are found mainly in the middle (nearly neutral) part of Figure 3.This effect may be one precondition for DCP-suitable pigments.

Therefore, besides coloristic aspects and dispersion capability even the electrostatic properties have to be considered. Typical pigments in use show preferred minor triboelectric influence.

Yellow Benzimidazolone Pigments—Coloristic and Charging Properties

Benzimidazolones types, e.g. Pigment Yellow 180, are diazo yellow pigments which have the following coloristic properties: good tinctorial strength, greenish to medium yellow shade, good lightfastness and good thermostability. Furthermore this pigment class is easy to disperse.

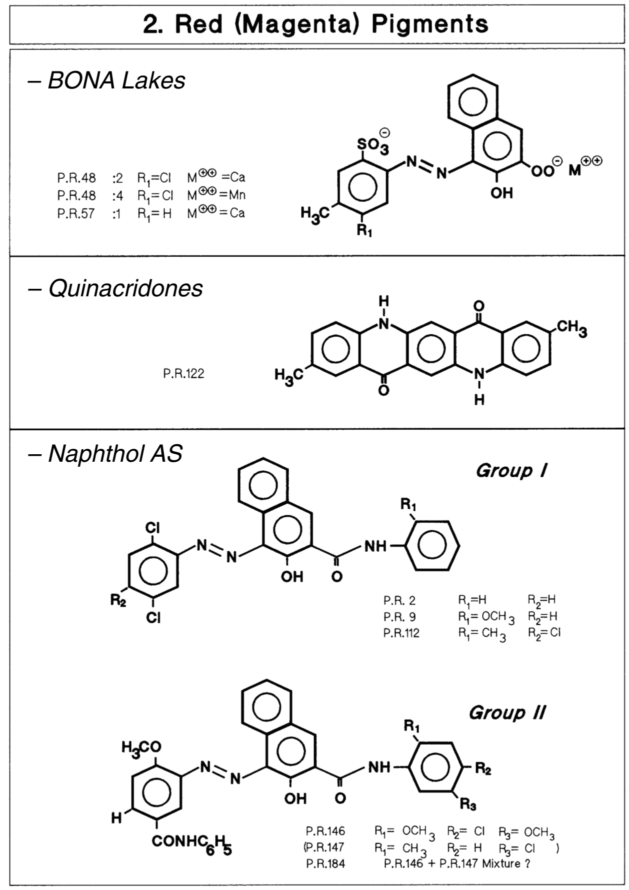


Figure 2. Typical magenta (red) pigments in use for digital color printing. BONA Lakes (traditional description) mean metal salt pigments on the base of 2-hydroxy-3-naphthoic acid, Naphtol AS means pigments on the base of 2′-hydroxy-3’-naphthoylanilide[7]. The group of quinacridones (P.R.122)[8] offers unique properties in terms of lightfastness, thermostability, and tinctorial strength. Their coloristic behaviour arises mainly from crystal lattice properties[7].

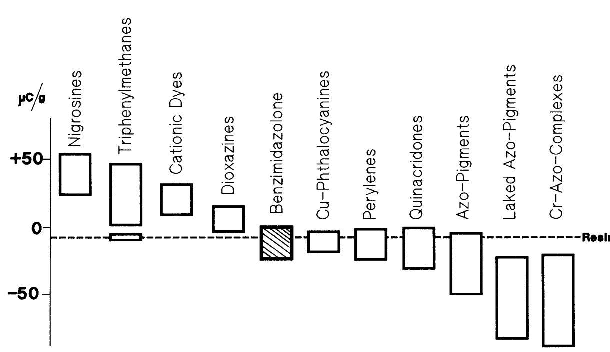
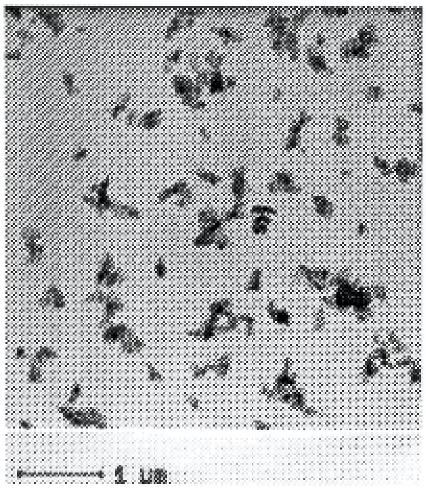


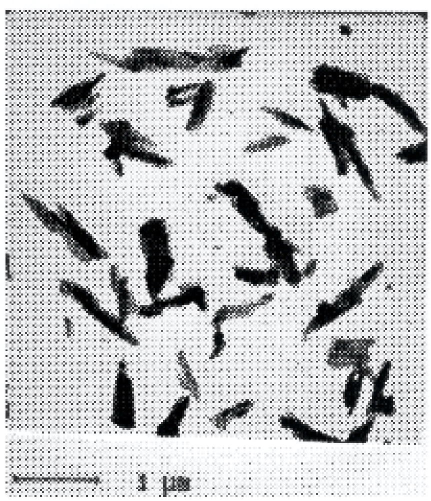
Figure 3. Effect of pigments from different chemical classes on the triboelectric charge of test toners. The broken line indicates the charge of the pure resin[10,11].

Table 1. Selected physical properties of two grades of Pigment Yellow 180

Type	Application	Transparency	Commercial Name	Specific Surface (m^2/g)	Particle size d_{50}: (μm)	Particle Shape	q/m-Value ($\mu C/g$)
1	toner	high	Toner Yellow HG	>60	0.12	more cubic	-9
2	plastic	low	PV Fast Yellow HG	24	0.32	rod like	-20



Type 1



Type 2

Figure 4. Electronmicrographs of benzimidazolone pigment P.Y.180, enlargement: 14400×. The newly developed tonergrade type 1 shows smaller particle size. The particles are more cubic. It is a pigment type with high transparency, excellent lightfastness, high tinctorial strength and high transparency. Unlike type 2 the electrostatic influence is lower.

The commercially available type 2 (Table 1) shows low transparency, since it was developed for good hiding power. In addition this type has significant charge influence. A newly developed type 1 (Table 1) for toner application exhibits improved transparency which goes parallel with enhanced specific surface and smaller particle size distribution. The pigment particles have a more cubic appearance (Figure 4). Furthermore the pigment demonstrates excellent fastness properties, high tinctorial strength, greenish yellow shade and high thermostability. The negative electrostatic charging is significantly reduced. Therefore small amounts of negative CCAs shift the q/m values of test toners to negative ones, positive CCAs to distinctly positive ones. Both electrostatic and coloristic properties of the new pigment type Toner Yellow HG are in accordance with the requirements.

Experimental

Test toners were prepared by dispersing the pigment (5%) into a polyester toner resin. The toner charge was measured on a commercial q/m-meter according to the literature[12].

Conclusion

Pigments for digital color printing have to fulfil both coloristic and electrostatic properties. Coloristic aspects like shade, tinctorial strength, and transparency are important as well as lightfastness and thermostability. To achieve an optimal degree of coloristic properties, a homogeneously dispersed pigment is necessary. Typical pigments in use exhibit a minor influence on tribocharging.

Therefore it is evident that pigments which fulfil both aspects are one step closer to high quality toners. It was shown that the newly developed yellow benzimidazolone pigment is in accordance with the above-mentioned requirements.

References

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= P.Y. 180; CAS No. 77804-81-0, benzimidazolone; Pigment Red 122 = P.R. 122, CAS No. 980-26-7; quinacridone; Pigment Blue 15= P.B. 15, CAS No. 147-14-8; Cu-phthalocyanine.

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