Next Generation Self-Dispersed Pigments for Aqueous Ink Jet

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Abstract

Cabot Ink Jet Colorants Division has commercialized a family of self-dispersed aqueous pigments for a decade. The proprietary surface modification technology is based on the application of the diazonium reaction with a variety of functionalized anilines. The choice of the functional group on the aniline plays a critical role in governing a variety of performance characteristics of the dispersion. Most recently, Cabot has developed materials where the functional group on the aniline treating agent is designed for selective interaction with components found in plain paper. This talk will focus on the performance characteristics that can be obtained through targeted design of the treating agent chemistry.

Introduction

The enhancement of print quality, measured by optical density (OD) or chroma, edge acuity, and intercolor bleed, on a wide variety of plain paper types has been a long standing objective for ink jet. Described herein is the development of a novel set of self-dispersed pigments that exhibit a step change in print quality on plain papers and represent the "next generation" of Cabot Ink Jet Colorants. These dispersions are capable of providing good storage stability in water and typical solvents used in ink jet inks at a wide range of temperatures.

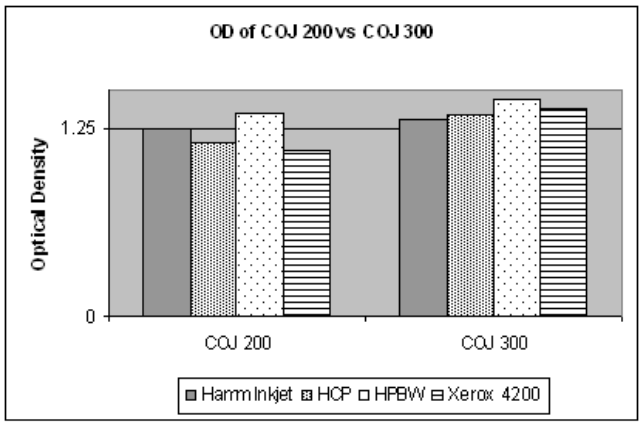
Mechanism of Paper Pigmentation

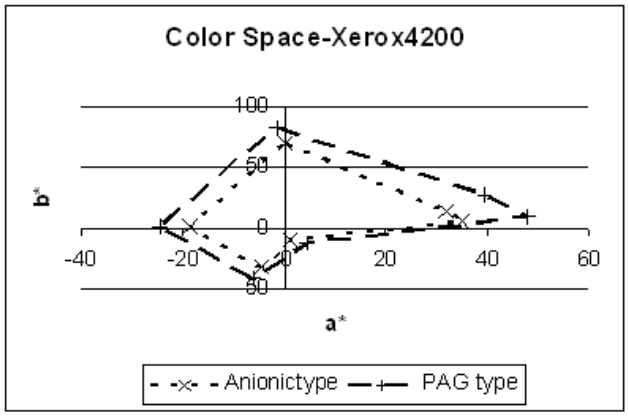
Traditional Cabot commercial self-dispersed pigments are formed through the diazonium treatment of a raw pigment. In this treatment chemistry, the reaction of a functionalized anilines (treating agent) in the presence of nitrite results in a surface modified pigment which has the treating agent attached to the pigment through a stable covalent bond. [1] The 200-series pigment dispersions use aniline that has a sulphonate group resulting in a sulphonated self-dispersed pigment. The 300-series pigment dispersions use carboxylated anilines and result in carboxylated type dispersions.

When these ca 100nm self-dispersed pigments of the 200 and 300 type are formulated into inks and jetted with an ink jet printer onto plain paper, they ultimately flocculate to form micron sized agglomerates that cannot penetrate into the paper. Hence, there is a competition between diffusion of these well dispersed particles which tend to deteriorate the print quality, and flocculation which immobilizes these particles. The more rapidly this flocculation takes place, the more likely the resulting agglomerate will reside on the paper surface and not be lost to diffusion into the paper. Of course, increasing the proportion of the pigment that resides on top surface of the paper results in elevated OD.

The chemical trigger for Cabot's sulfonated pigments (200 series) is thought to be flocculation induced by high ionic strength of the ink. The elevated ionic strength of the ink on plain paper is induced by the dissolution of soluble salts present in the paper. In the case of the carboxylated pigments (300 series) there is thought be the added mechanism of pH, where a drop of pH to about 6 is sufficient to accelerate the flocculation of the carboxylated pigment dispersion resulting in elevated OD.

Figure 1 – OD of COJ200 vs COJ300 and Color Space





Print Quality Improvement by the Use of a Paper Affinity Group (PAG)

Cabot has a long standing interest in developing self-dispersed pigments that function by use of chemical mechanisms that can be triggered by chemical components present in plain paper. Chemical functional groups that react preferentially to specific paper components are referred to Paper Affinity Groups. [2] A demonstration of the advantage of designing self-dispersed pigments where the treating agent used to surface modify the particle possess functional groups with varying affinity for a

divalent ion such as calcium is shown in Figure 2. Clearly, the treating agent with the highest affinity for calcium ion flocculates at a much lower calcium ion concentration than the material, in this case COJ300, with the least affinity. Figure 3 compares the maximum OD obtained from these materials on an ink jet print. [3]

We have found that PAGs of this type also improve print quality by enhancement of paper type independence (OD) and intercolor bleed (Figures 4 and 5 respectively).

Figure 2 – *Flocculation Kinetics in the Presence of Ca++ Ion*

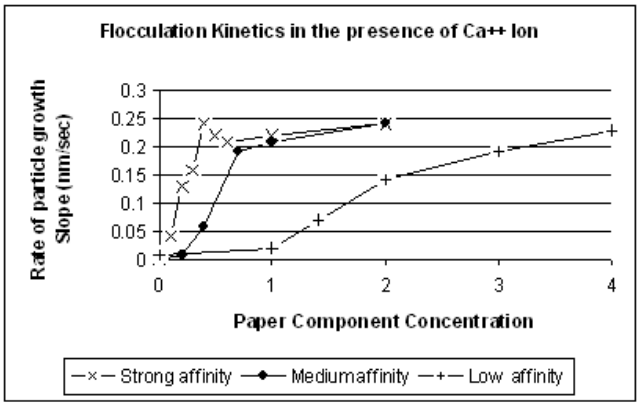


Figure 3 – *OD scan of 300 and 400*

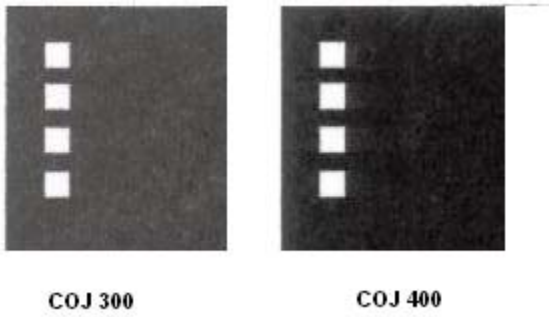


Figure 4 –*Paper Type Independence*

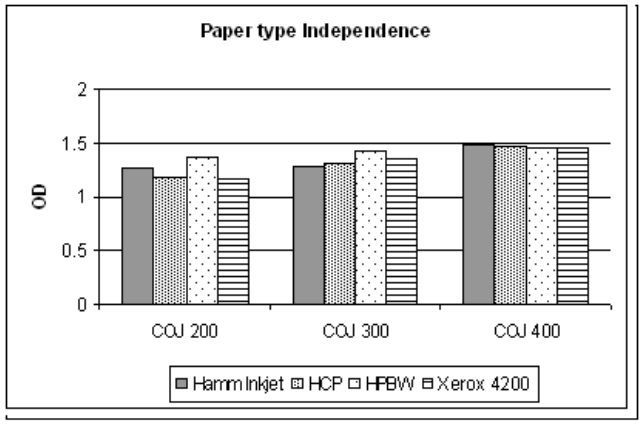
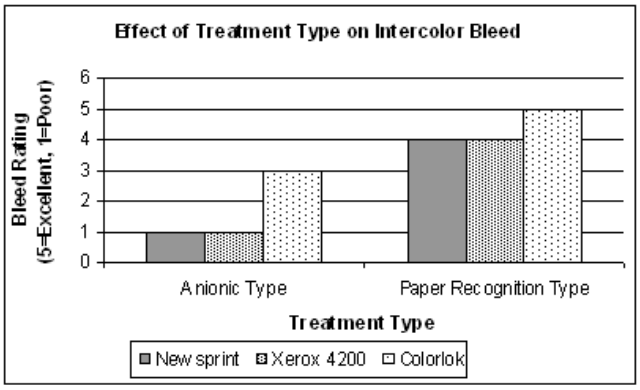


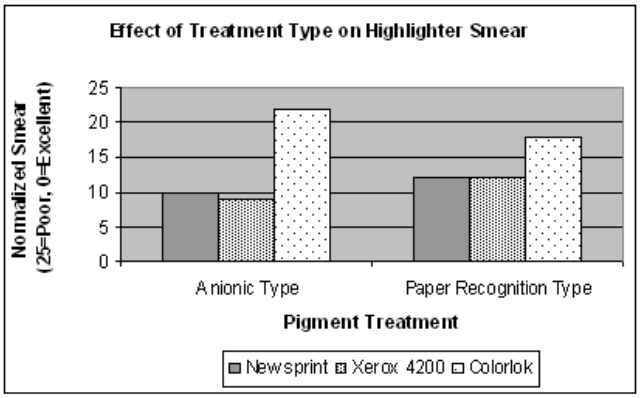
Figure 5 –*Inntercolor Bleed of COJ300 vs COJ400*



Print Durability Improvement by the Use of a Paper Affinity Group (PAG)

An unfortunate trade-off experienced in ink jet images is that image durability is degraded as the print OD is improved. The root cause is clear since the more colorant that resides on the top surface of the print, the greater the smear when it is rubbed with a highlighter or fingers. The relative durability improvement experienced when colorants containing PAGs were subjected to durability testing was an unexpected result. While their performance is far from perfect, the PAGs apparently enhance image durability. The specific mechanism for this effect is unproven, but may well be a combination of greater inter-particle cohesion (e.g. flocculated particles are more stable) as well as stronger binding of the flocculated particles to the paper itself.

Figure 6 ***Effect of Treatment on Highlighter Smear***



Normalized Smear = 100x (smeared ink OD)/(Max OD) (1)

Conclusions

We believe that ink jet print quality and print durability can be significantly enhanced by the use of self-dispersed colorants containing a Paper Affinity Group (PAG). Since there are many chemical components present in plain paper, there is a wide range of opportunities available to tune the performance of self-dispersed colorants.

Biography

Barry B. Corden is the Director of Research and Development of the Ink Jet Colorants Division of Cabot Corporation located in Billerica MA. Prior to his employment at Cabot, he has held various positions at Polaroid Corporation and Tufts University. He received his PhD in Chemistry at the University of Illinois (Urbana).

References

[1] Yu, Y. and von Gottberg F., "Surface Modified Color Pigments for Inkjet Ink Application" Page 512-515, IS&T 16th International Conference, October 2000, Vancouver, Canada.

[2] Self-dispersed pigments that flocculate in response to the elevated ionic strength of an ink as it dissolves salt species found in plain paper is considered as a non-specific chemical response, since loss of colloidal stability would occur in any ionically stabilized colloid.

[3] These images were obtained when the pigment load, ink vehicle, paper type and printer are fixed and identical for each dispersion. This trend is observed when these four factors are varied systematically, although the absolute offset in OD measured does change.