



# Aqueous Dispersed Pigments for Single Pass, High Speed Commercial Inkjet Printing

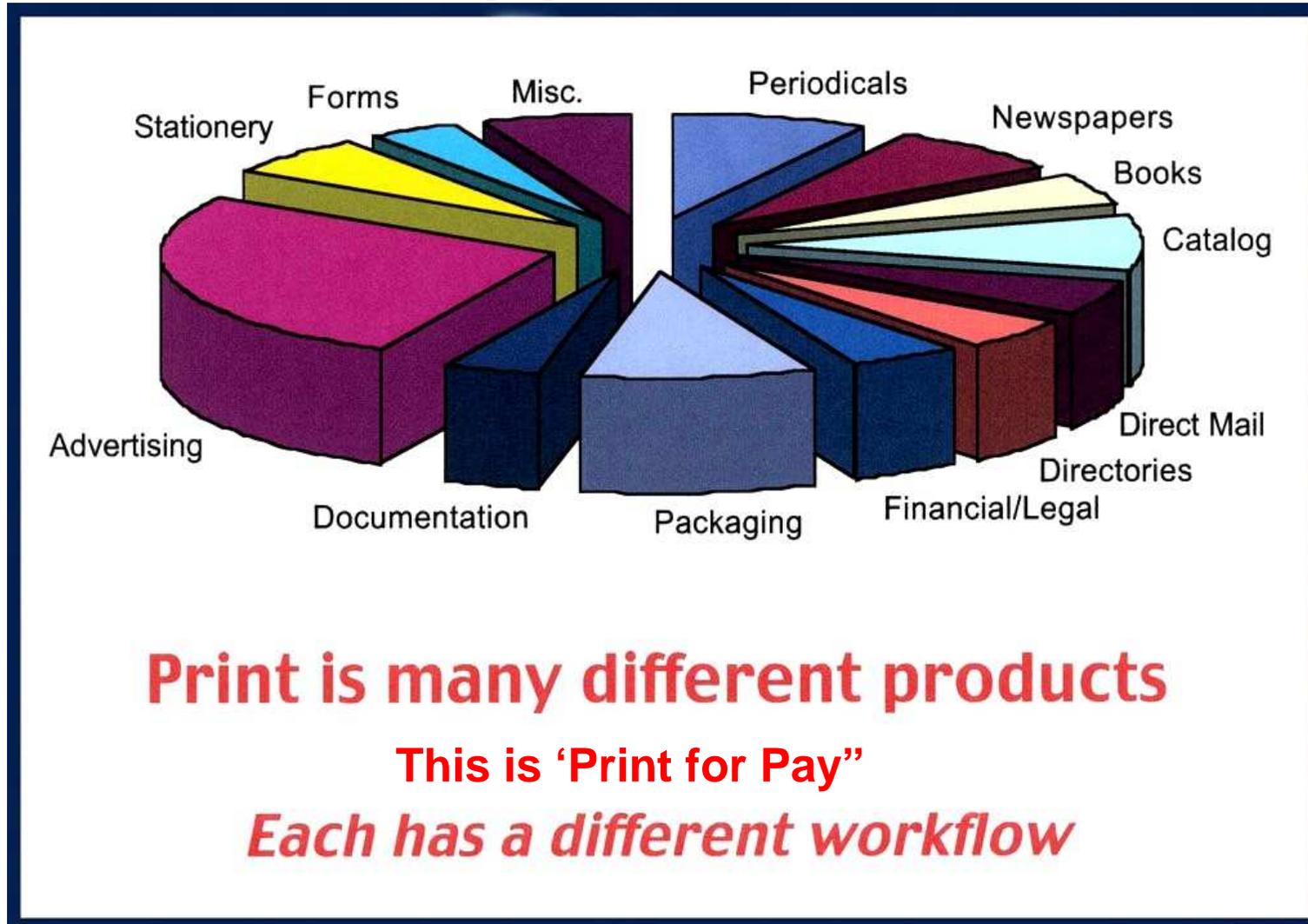
CAB-O-JET® Inkjet Colorants: An enabling solution

November 2008

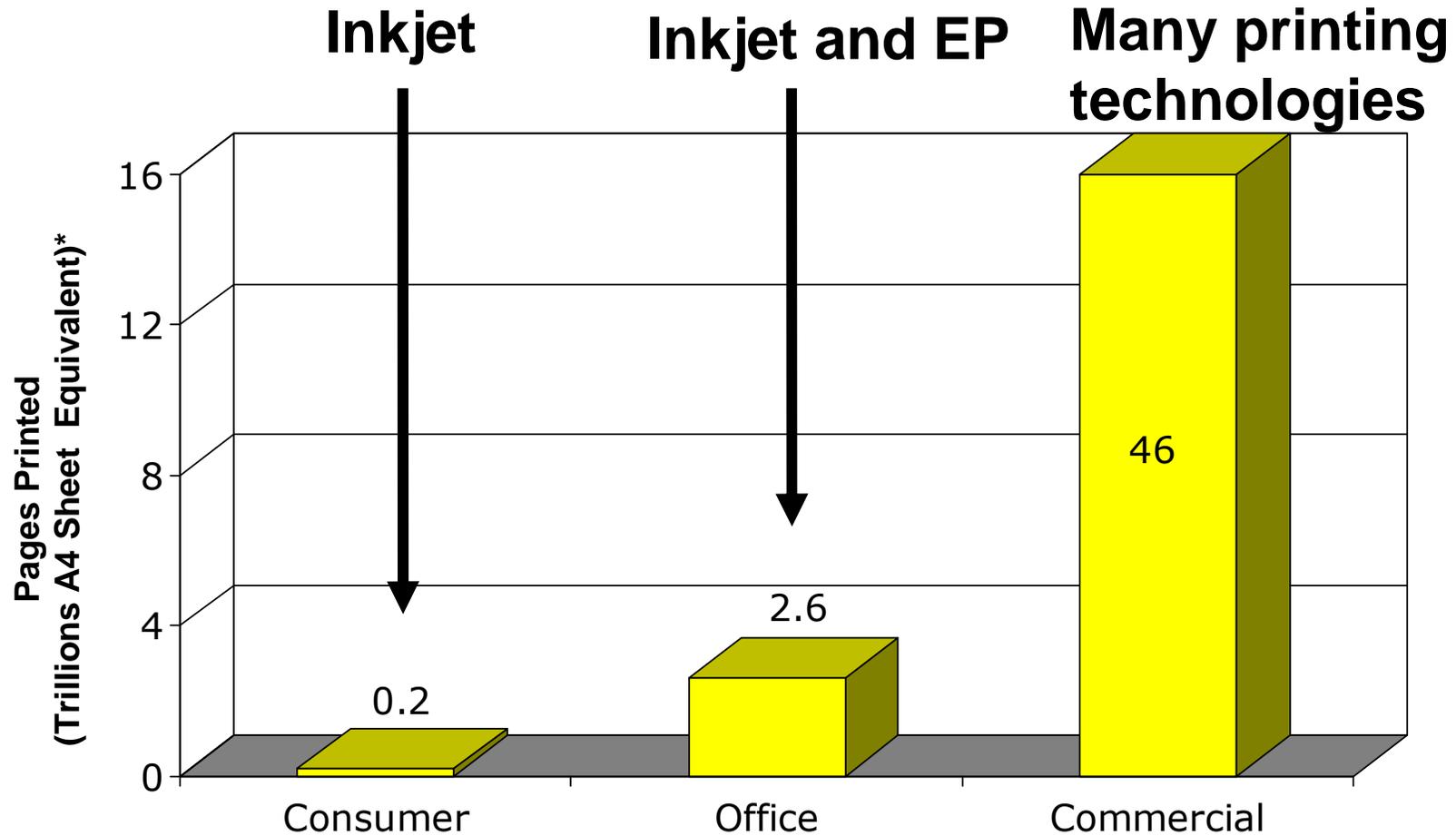
# Agenda

- Commercial printing industry trends
  - Offset vs Digital
  - Toner vs Inkjet
- The opportunity for inkjet
  - Strengths for inkjet
  - New market entries
- Making Inkjet work:
  - Dyes vs Pigments
- Aqueous pigment dispersion chemistries:
  - Conventional vs surface modified pigments
- Performance of surface modified pigments
  - Meeting the needs for single pass, high speed printing
- Summary
  - Aqueous pigments are the best choice

# Commercial Printing Applications



# Size of the Commercial printing market.



From: Lyra

# Distribution of Print Volume by Process

<i>Printing, Publishing and Packaging</i>	<u>2006</u>	<u>2015*</u>
Offset Lithography	42%	38%
Conventional plates	39%	31%
Waterless plates	3%	7%
Gravure	19%	17%
Flexography	19%	21%
Letterpress	4%	2%
Screen & other Plate Systems	2%	2%
Digital:	12%	20%

**Decreasing**

**Increasing**

**Estimate Of Total Digital in 2015: Inkjet = 50%; Toner = 48%; Other = 2%**

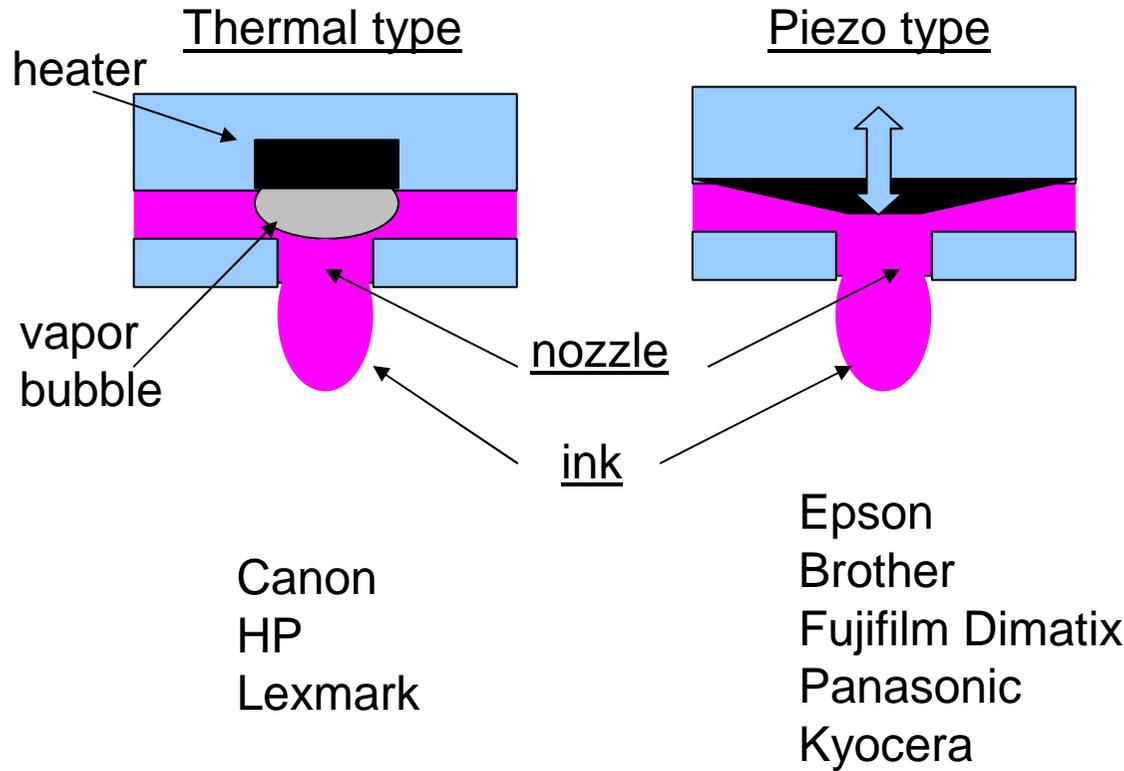
## Trends in the printing industry

- Shorter runs
- More color
- Faster turn around time
- Various papers
- “Distribute and Print”
- “Personalization”
- Lower costs
- **Digital printing can satisfy these requirements better than conventional**

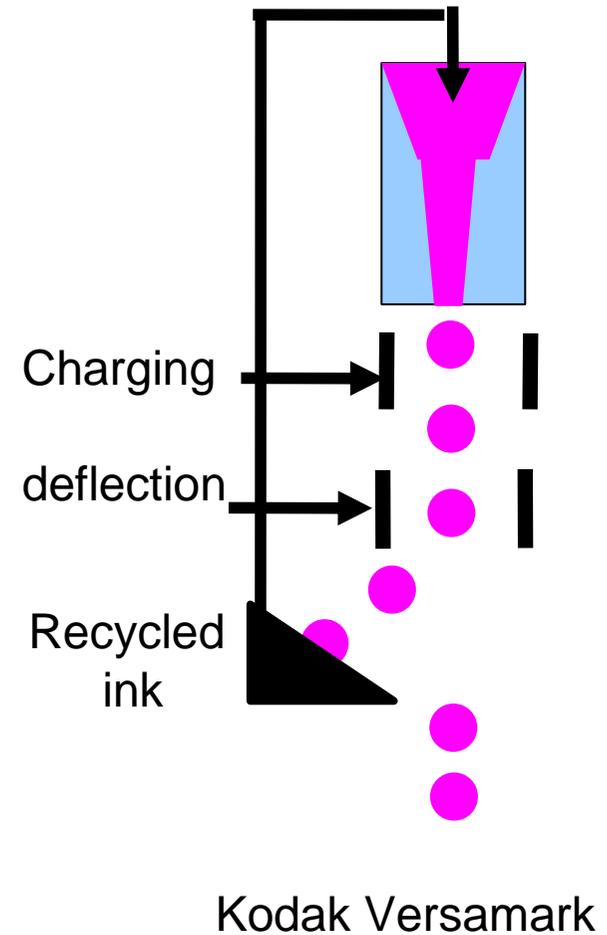


# Types of Inkjet Print Heads:

## Drop on Demand

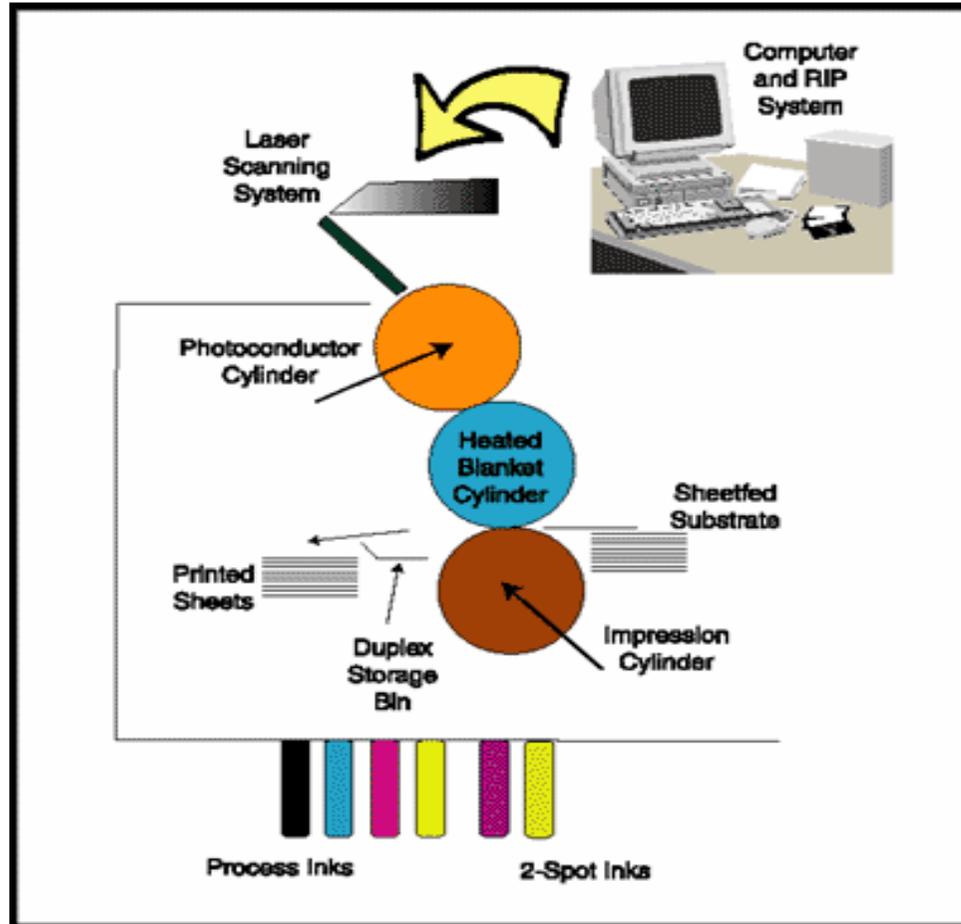


## Continuous



All three can work with pigmented inks

# Toner Processes



Canon  
Ricoh  
Xerox  
HP

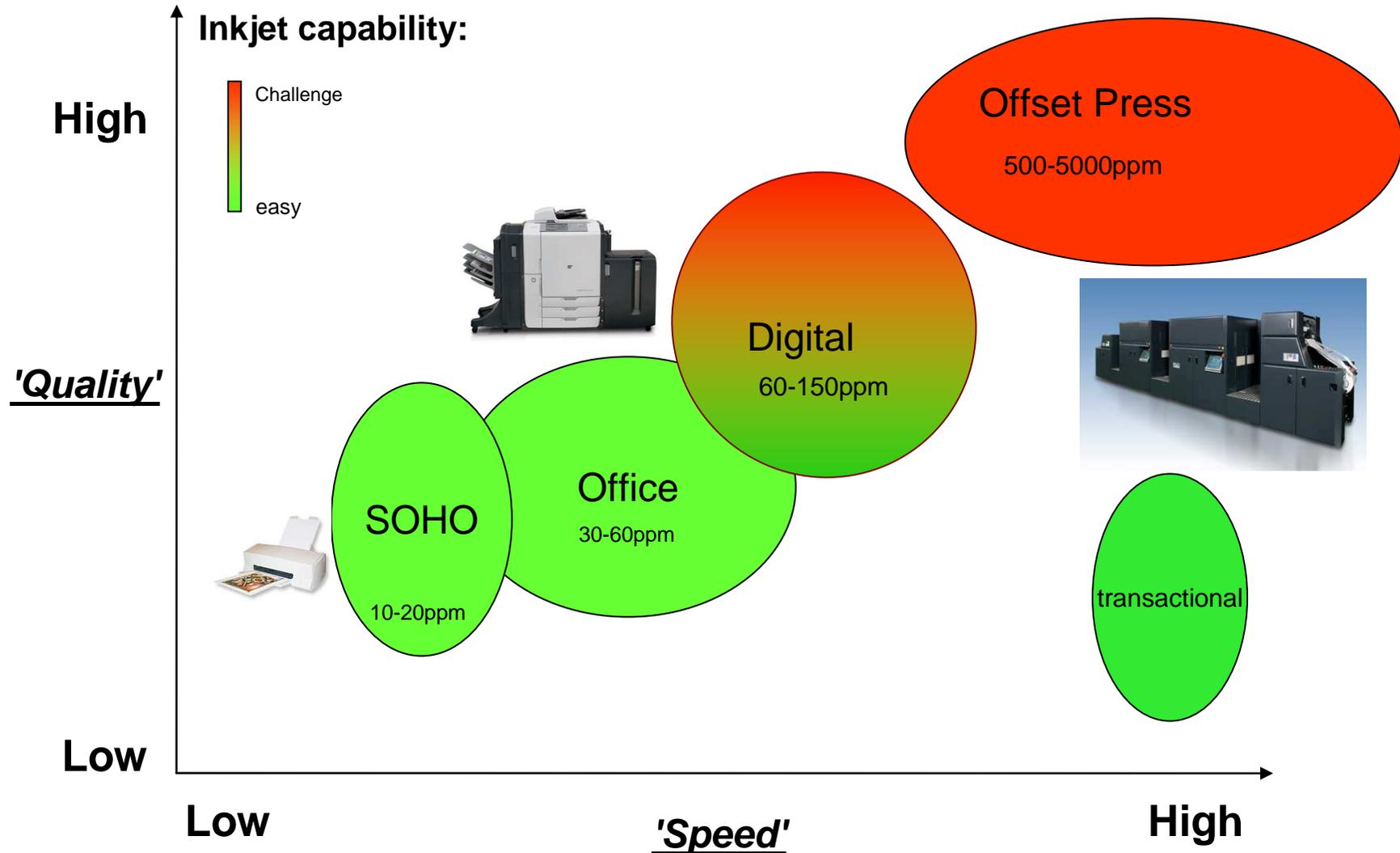
Can be 'dry' or 'liquid' toner

# Comparison of Inkjet vs Toner

	<u>Inkjet</u>	<u>Toner</u>
Hardware simplicity	+	-
Cost	+	-
Reliability	+	+
speed	+	- (fusing limitation)
Quality	-	+
Paper versatility	-	+
Technology status	Advancing	Mature
“Scalability”	+	-

– Both will coexist and find their niche in the commercial printing markets.

# Speed/Quality Printing Landscape



# Opportunities and Challenges for Inkjet

- Opportunity:
  - Speed and cost: Inkjet can be expected to print at the higher speeds at lower cost vs toner.
  - Hardware simplicity: 'Non contact' printing, no fusing, lower energy demands.
- Challenge:
  - Ability to print on many types of papers, including non absorbing
  - Distortion in paper at high coverage and difficulty in being able to ability to achieve large areas of solid fill
  - Recyclability

# Single Pass Inkjet product Launches at DRUPA



# HP Web Press



Speed: 122 m/min  
(2600 A4/min)

Colorant: Aqueous pigments

Printhead: TIJ, (HP)

Resolution: 600 x 600 dpi

Fixer: Yes

**For printing on uncoated papers.**

**Books, Newspapers, Direct Mail and Transactional**

## Oce JetStream 2200



**Speed: 150 m/min  
(2200 A4/min)**  
**Colorant: Aqueous dye**  
**Printhead: Piezo (Kyocera)**  
**Resolution: 600 dpi**  
**Fixer: none**

**Twin Engine system.**  
**DigiDot technology allows for  
variable dot size printing.**  
**Target market: Direct Mail and  
Transactional printing.**

# Dainippon Screen Truepress Jet520



Speed: 64m/min (1400 A4/min)  
Colorant: Aqueous Pigment  
Printhead: Epson Resolution: 720 x 720  
Fixer: none

Target Market segments:  
TransPromo, newspapers,  
direct mail, etc

# Kodak Versamark VL2000



**Speed: 75 m/min  
1008 (A4/min)**

**Colorant: Aqueous  
Pigments  
Printhead: Panasonic  
Resolution: 600 dpi  
Fixer: none**

Target Markets: TransPromo,  
Direct mail and transactional

# iMPiKA iPress 600



Target Markets:  
Direct Mail, Transactional,  
Labelling

**Speed: 75 m/min  
(1200 A4/min)**

**Colorant: Aqueous dye or  
Pigment**

**(4-6 colors)**

**Printhead: Panasonic**

**Resolution: 600 x 600**

**Fixer: none**

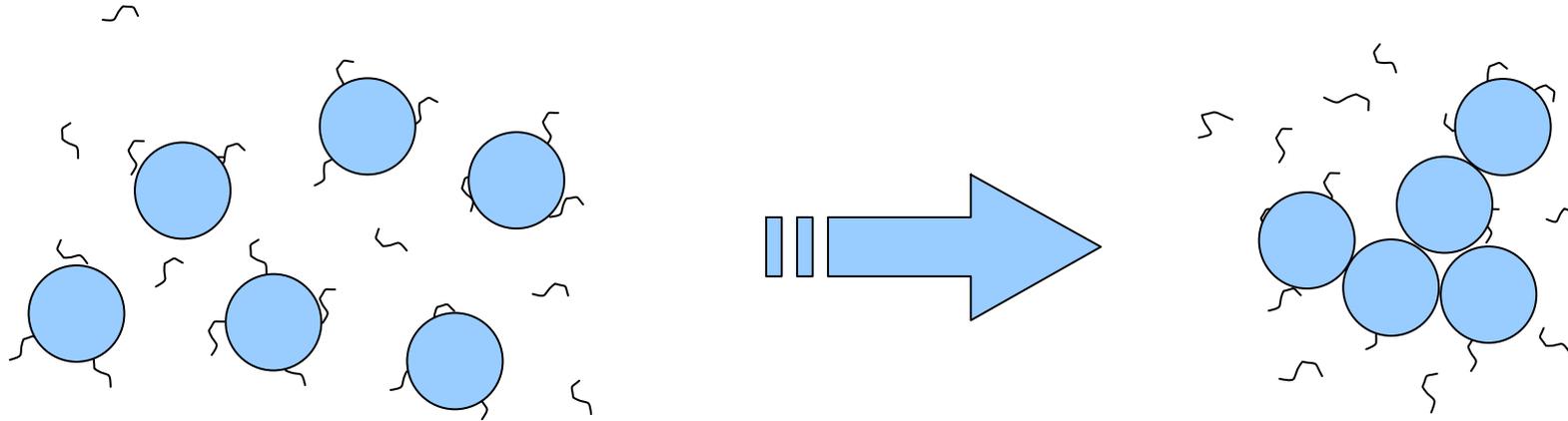
# Dye vs Pigment for Aqueous Inkjet

	<u>Dye</u>	<u>Pigment</u>
Cost*	low	med
Vivid Color	+	-
Recyclability	-	+/-
Lightfastness	-	+
Formulation Flexibility	+	-
Printhead Reliability	+	-

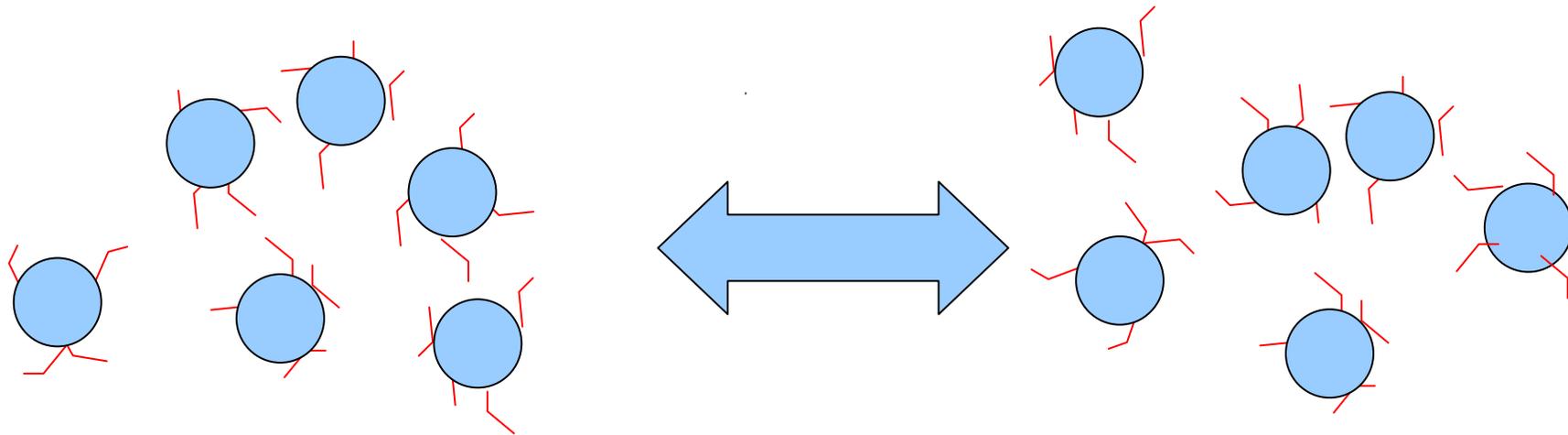
# Why use Pigments for Commercial Inkjet Printing?

- Durability
  - Books, Trans-promo, Tax Bills and marketing collateral all require image durability.
- Customer Expectations:
  - Pigments are used in offset printing.
  - Perceived value of pigments is high.
- Interaction with Media:
  - Dye's tend to diffuse on low grade media.
  - Use of fixers and binders 'lock in' pigments and can also make the paper 'recyclable'
- Competitive positioning by major companies:
  - HP, Epson and Kodak have pigment offerings

# Colloidal Stability of Pigments

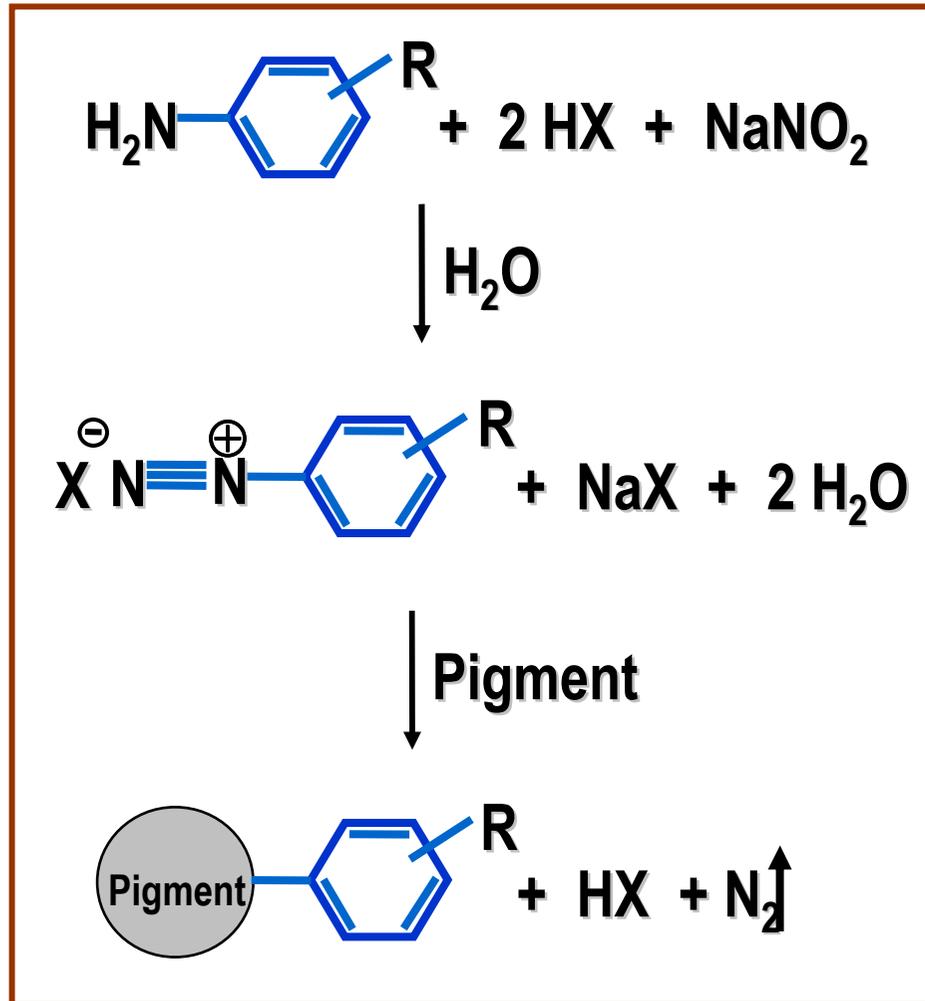


**Adsorbed** stabilizers can diffuse off the pigment and lead to flocculation

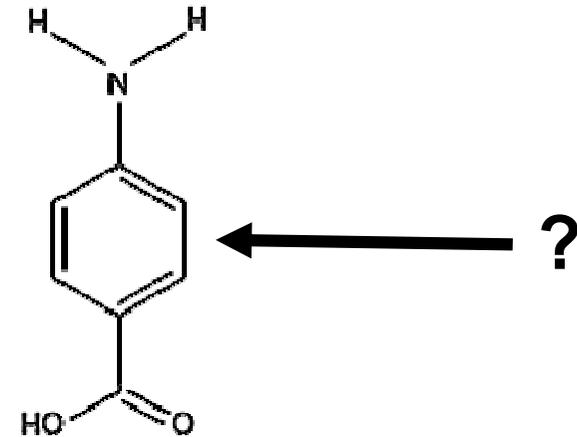


**Attached** stabilizers provide stability under a variety of conditions

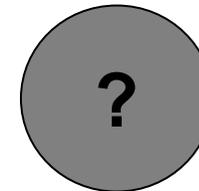
# Cabot's Diazonium Attachment Chemistry



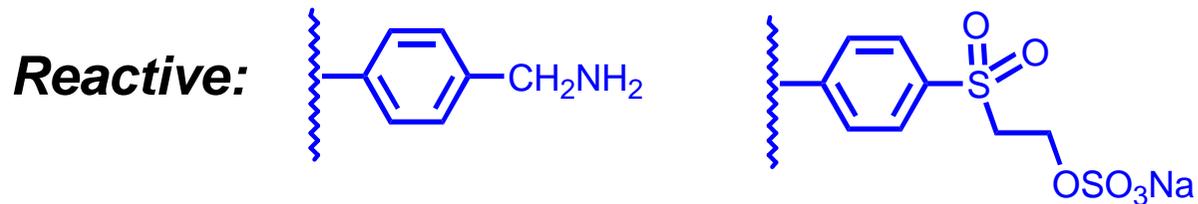
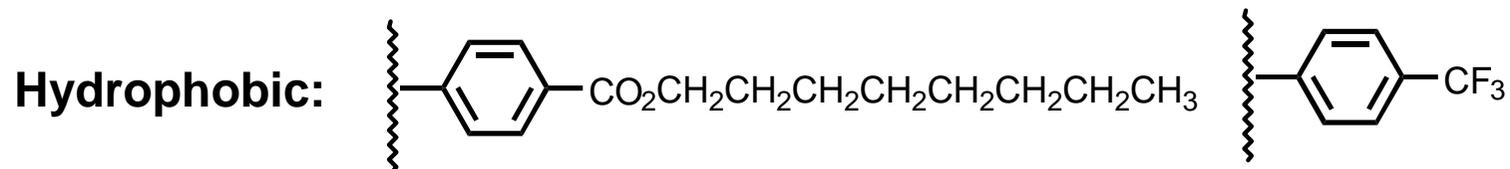
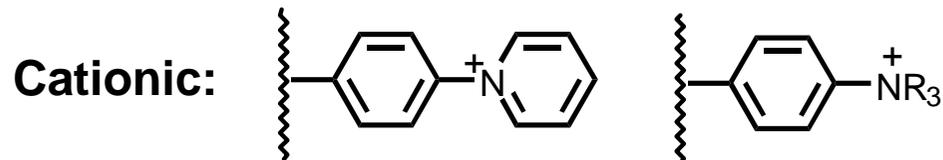
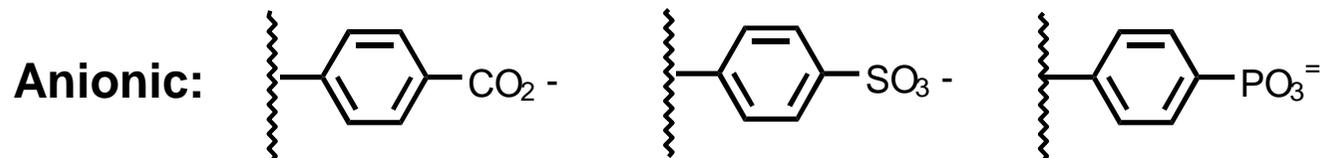
What type of groups can be attached?



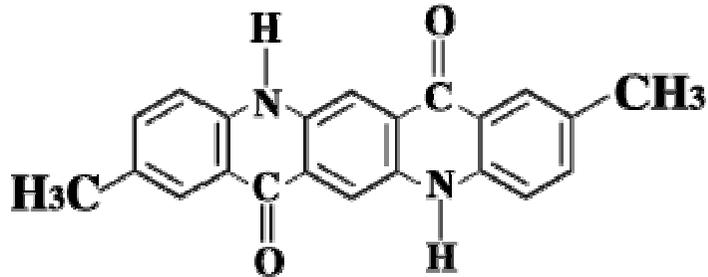
Which pigments can be treated ?



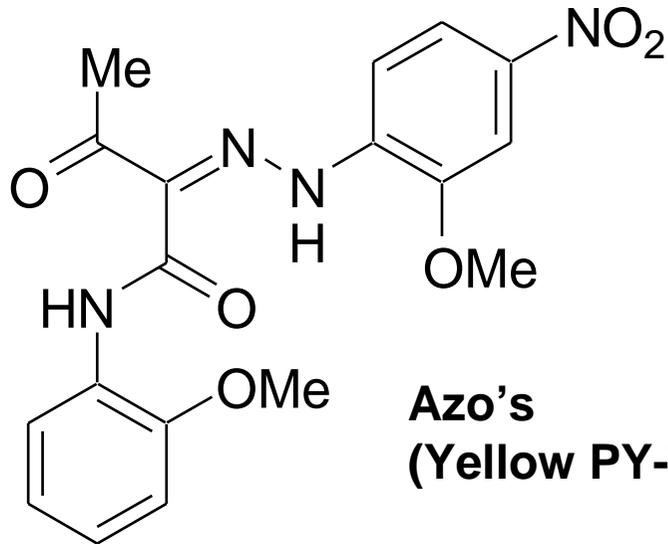
## Examples of Functional Groups:



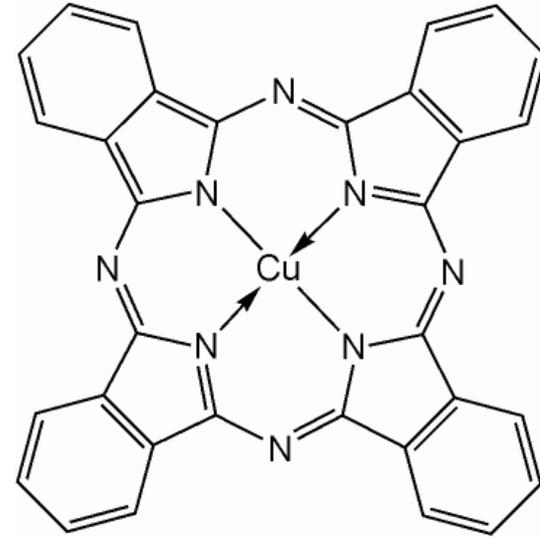
# Classes of Pigments Which can be Treated:



**Quinacridones,  
(Magenta PR-122)**

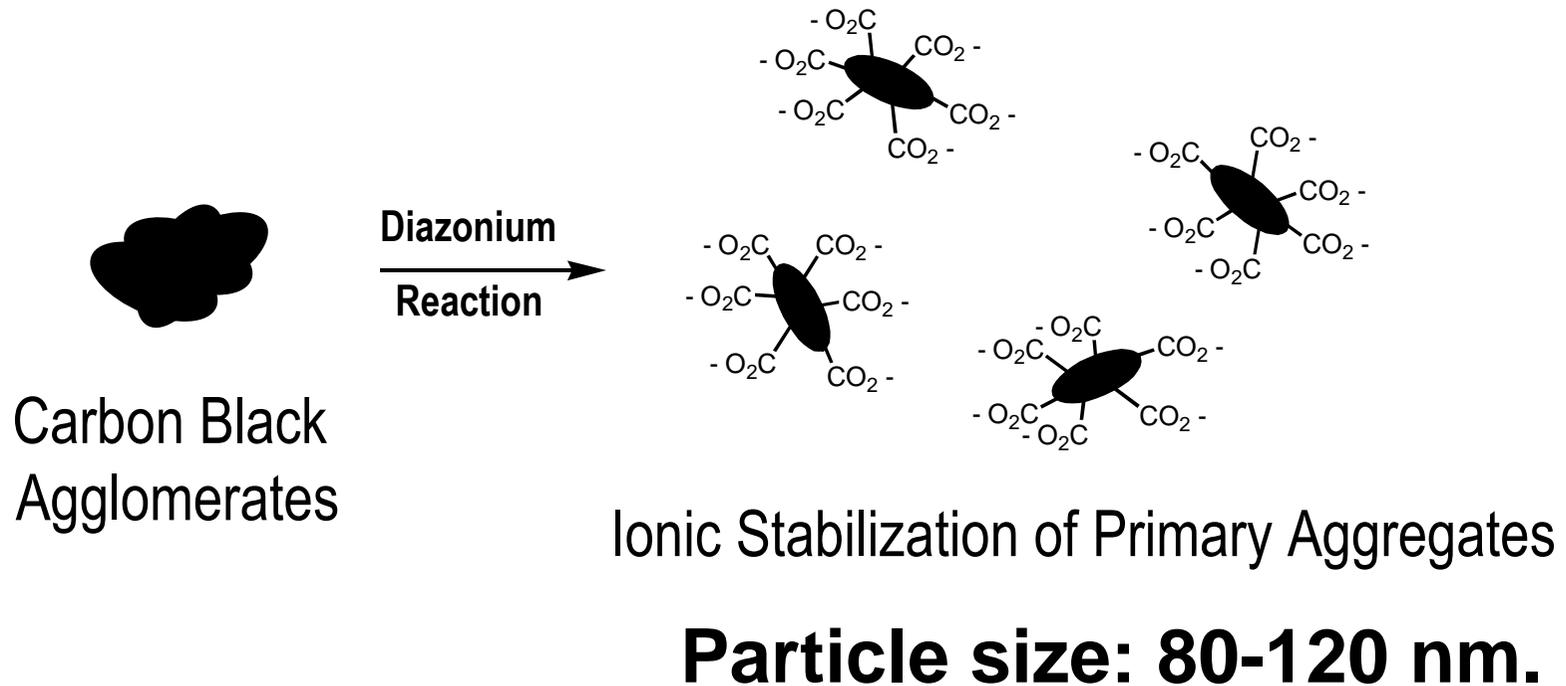


**Azo's  
(Yellow PY-74)**



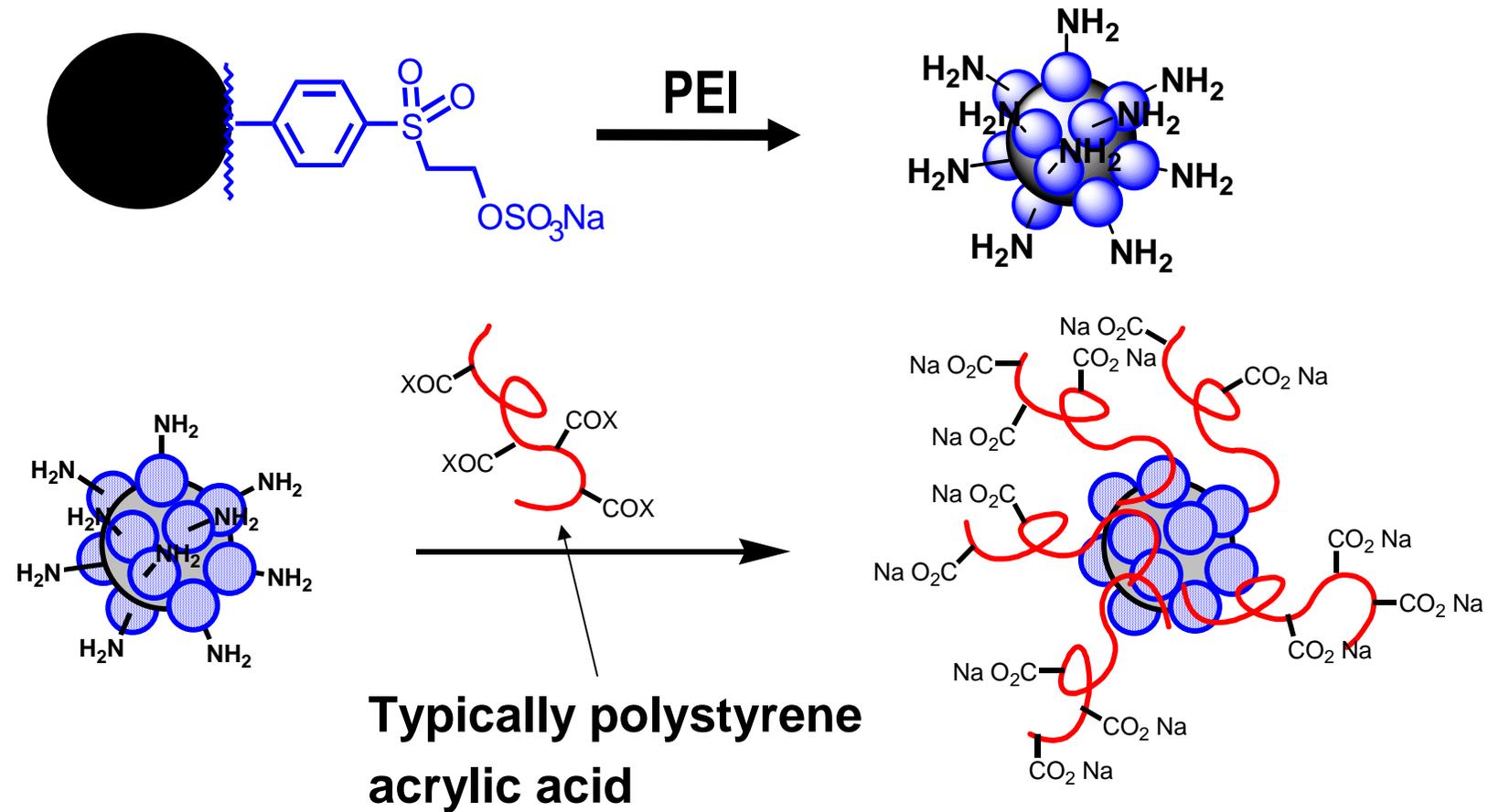
**Copper Phthalocyanines  
(Cyan PB 15:4)**

# And, of course, Carbon Black:





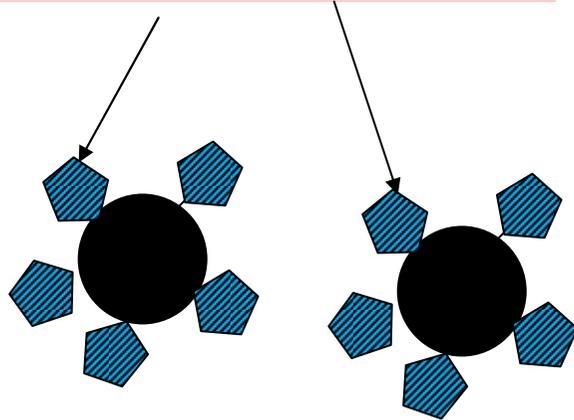
# Polymer Attachment made by Reactive Groups



**Ionized at high (9) pH**

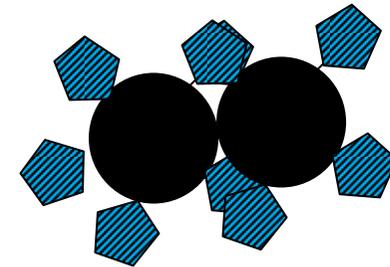
# A New Class of Treatment: Recognition Groups for Paper Components

Molecules which strongly  
Interact with paper



Particles are highly  
charged and stable in ink

Printed on paper



Interaction with paper causes  
rapid flocculation of  
the pigments

“Self Fixing”

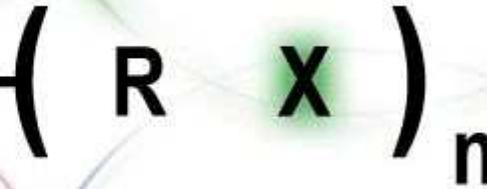
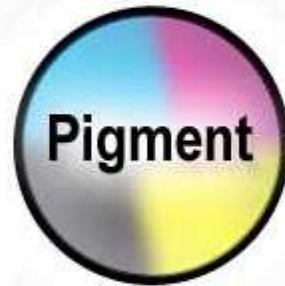
# Surface Modification Summary

## Treatment Type

- Ionic (+ and -)
- Non-ionic
- Multiple/additional treatments
- Polymers

## Counterion Type

- Negative/Positive
- Organic/inorganic
- Small molecules/polymers



## Pigment Type

Black  
Cyan  
Magenta  
Yellow

## Treatment Level

adjusted for desired properties

# The Needs of Commercial Printing:

- Image Durability
- Color Gamut
- Image Quality
- Paper Independence
- Jetting reliability
- Fast fixing on paper
- Environmentally friendly
- Recyclability/deinking
- Low cost



## The Interaction of Ink/Media

- Print properties depend on ink/media interactions:
  - Absorption characteristics of the paper.
  - Method of drop placement (ie, avoiding adjacency).
  - Use of heated drying.
  - Use of fixer in the paper (such as Colorlok)
  - Applying fixer to any paper prior to printing.

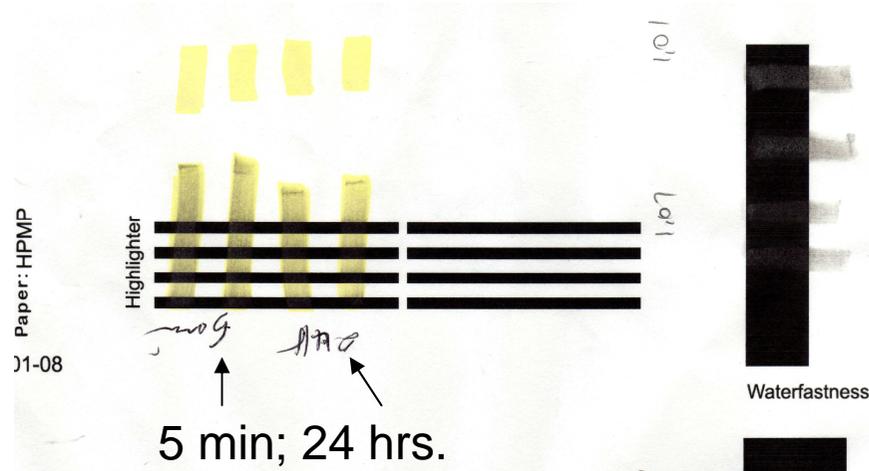
## Experimental Testing

- Surface modified treated pigments tested:
  - Anionic type, paper recognition (PR) type and polymer attached (PA) type.
  - Ink type: Simple piezo, only water, pigment, co-solvent and surfactant.
  - Printer used: Epson desktop C88
- Papers tested:
  - Xerox 4200, Newsprint, and ‘fixed paper’ :ColorLok<sup>®</sup>

## Properties Tested and Method:

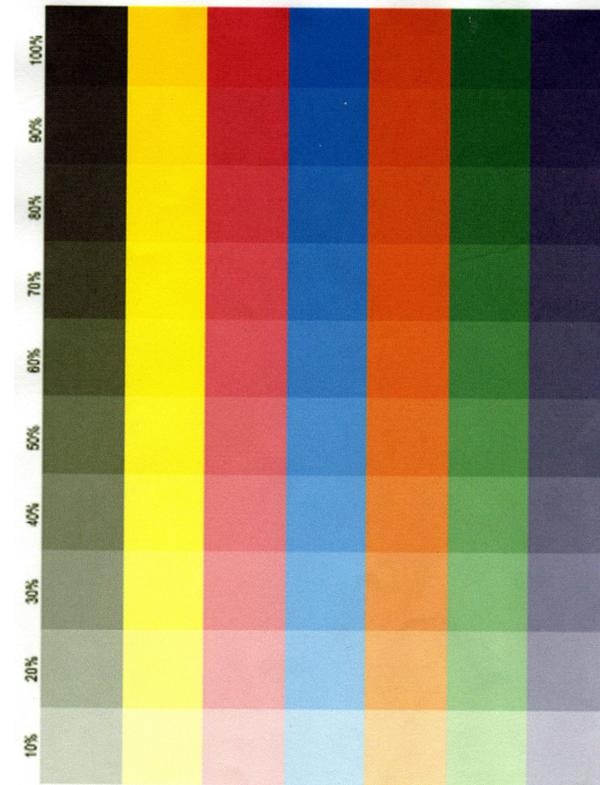
- OD: Gretag Spectro Eye
- Highlighter Smear: 2 pass Sharpie Accent Yellow @ 24 hours.
- Wet Rub Smear: 2 pass water filled Accent Highlighter @ 24 hours
- Color Gamut: Gretag Spectro Eye Spectrodensitometer
- Intercolor Bleed: ImageXpert and Visual ranking

Highlighter  
Smear tests



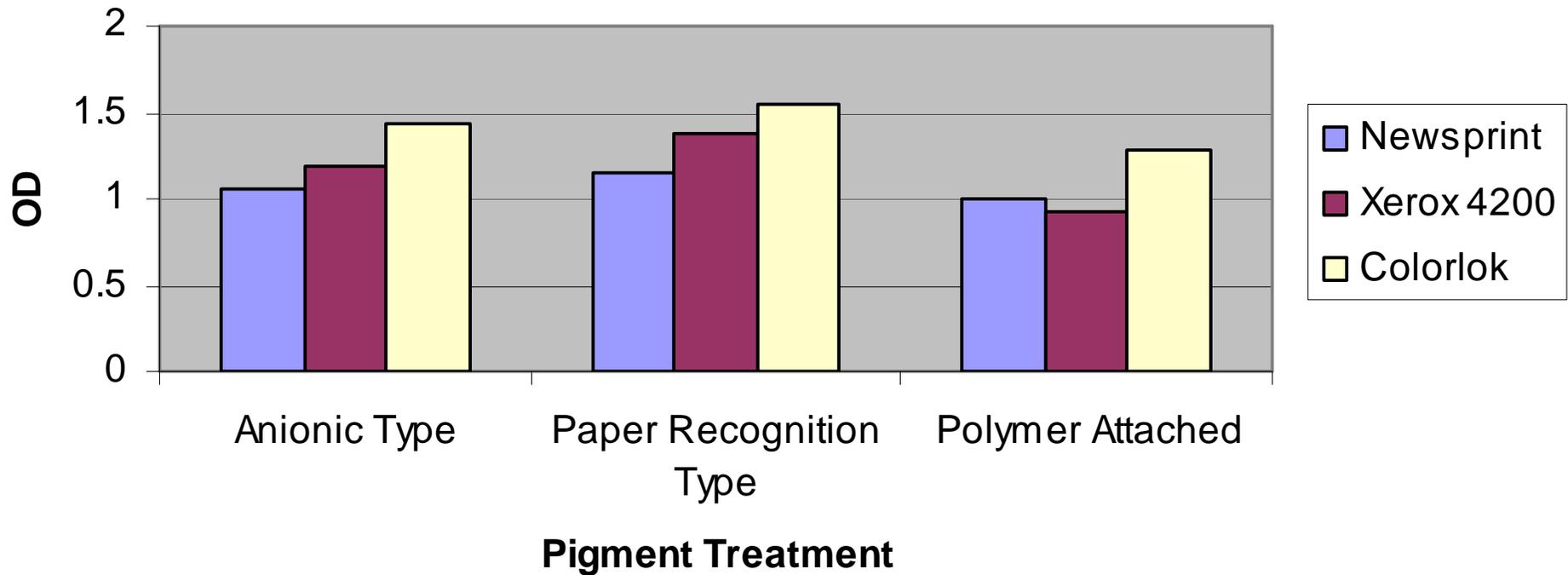
Wet rub tests

For color gamut  
measurements



OD and  
dry rub  
tests

# Effect of treatment type on OD

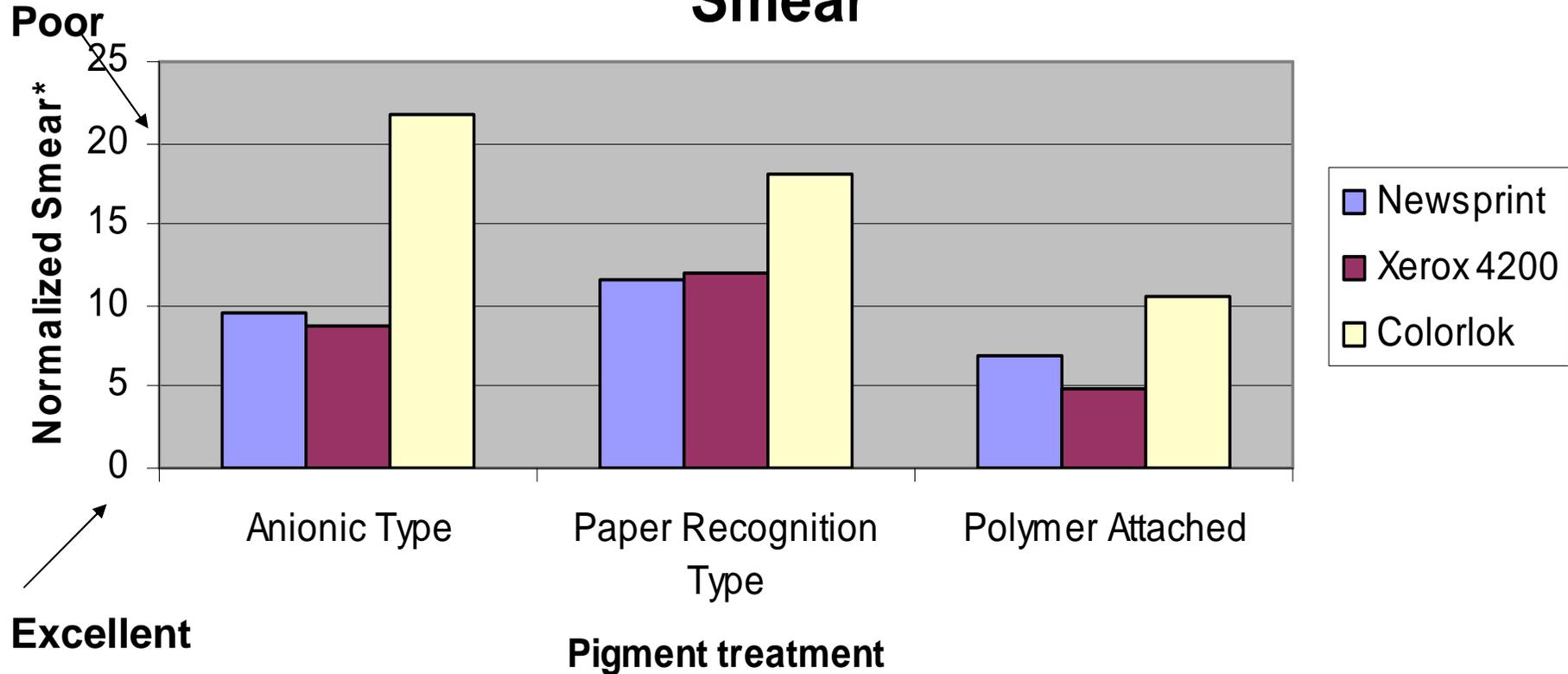


OD trend: PR type is best.

PA causes OD to be lower.

Colorlok always larger.

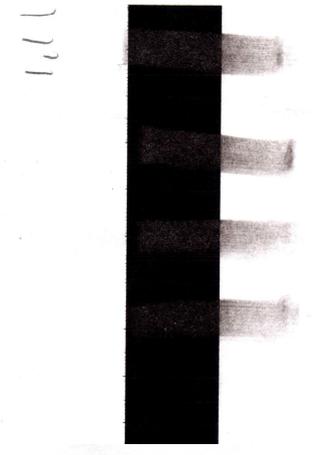
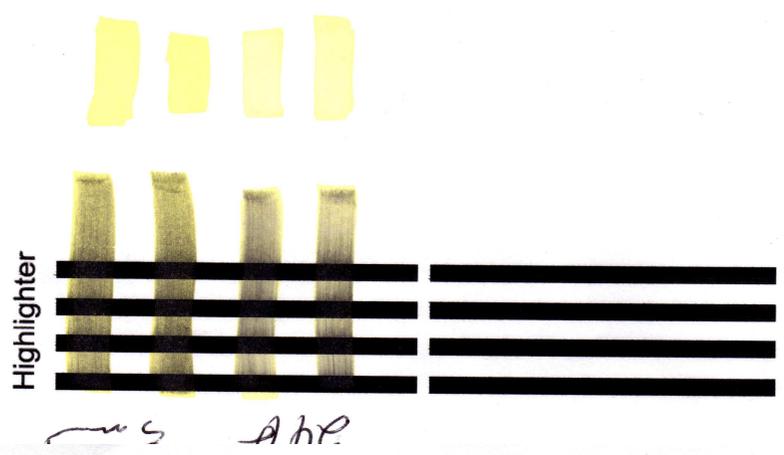
# Effect of Treatment Type on Highlighter Smear



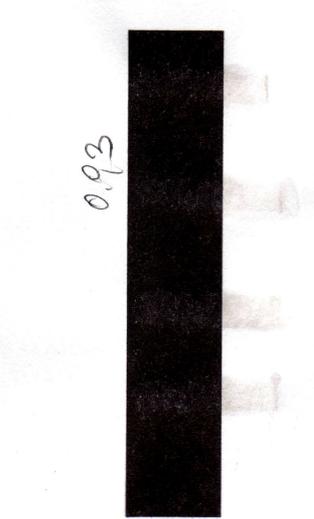
**Smear Trend: PA best (but tradeoff with OD). Some improvement seen with PR type and fixer.**

**\*Normalized Smear = 100x(smear ink OD)/(Maximum OD)**

# Examples of good and poor highlighter smear and wet rub



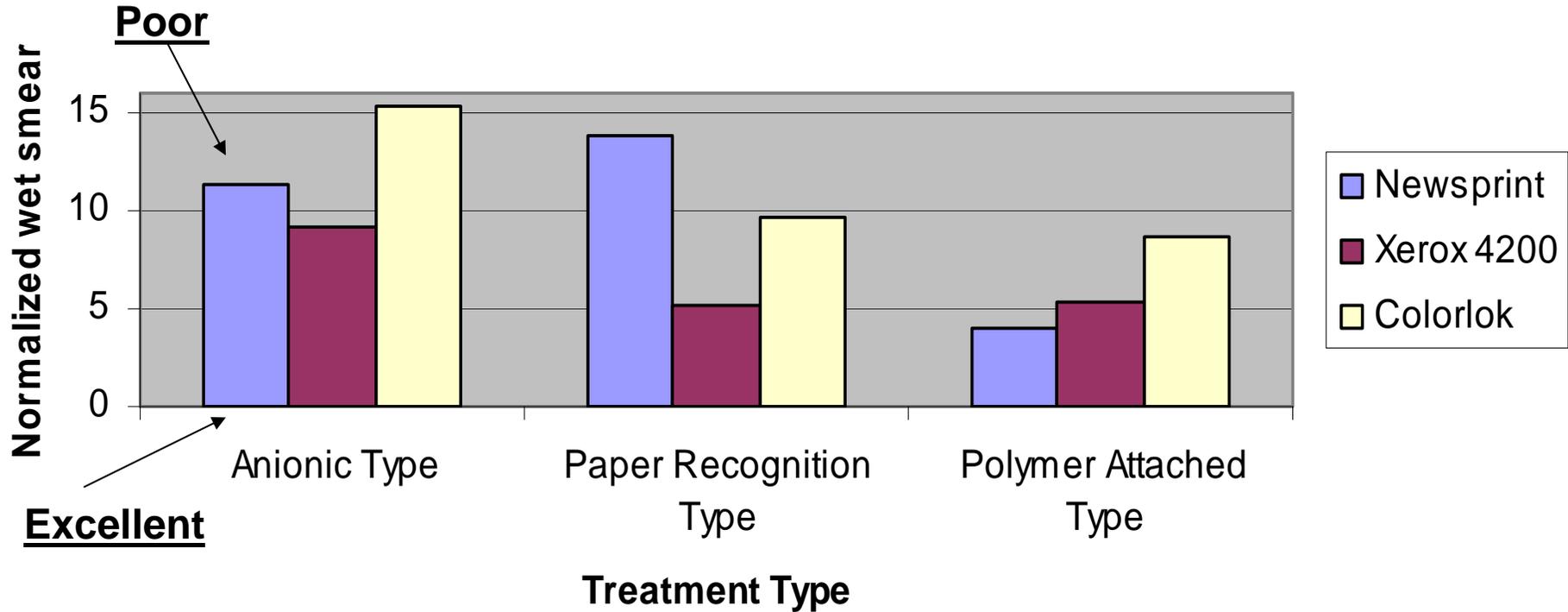
Anionic type pigment on Colorlok Paper (but good OD)



Polymer Attached pigment On Xerox 4200 paper. (OD is lower also).

Waterfastness

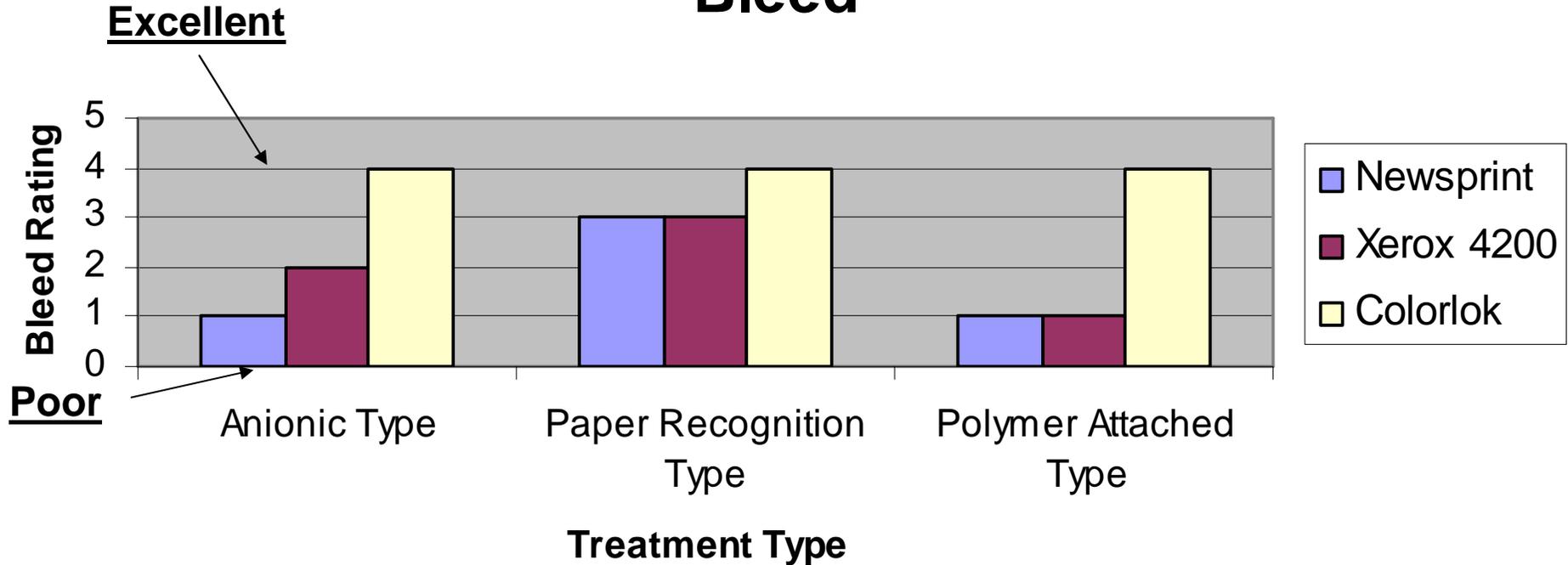
# Effect of Treatment Type on Wet Rub



Wet Rub trend is the same as for smear – Trade off with OD.  
None are 'excellent'

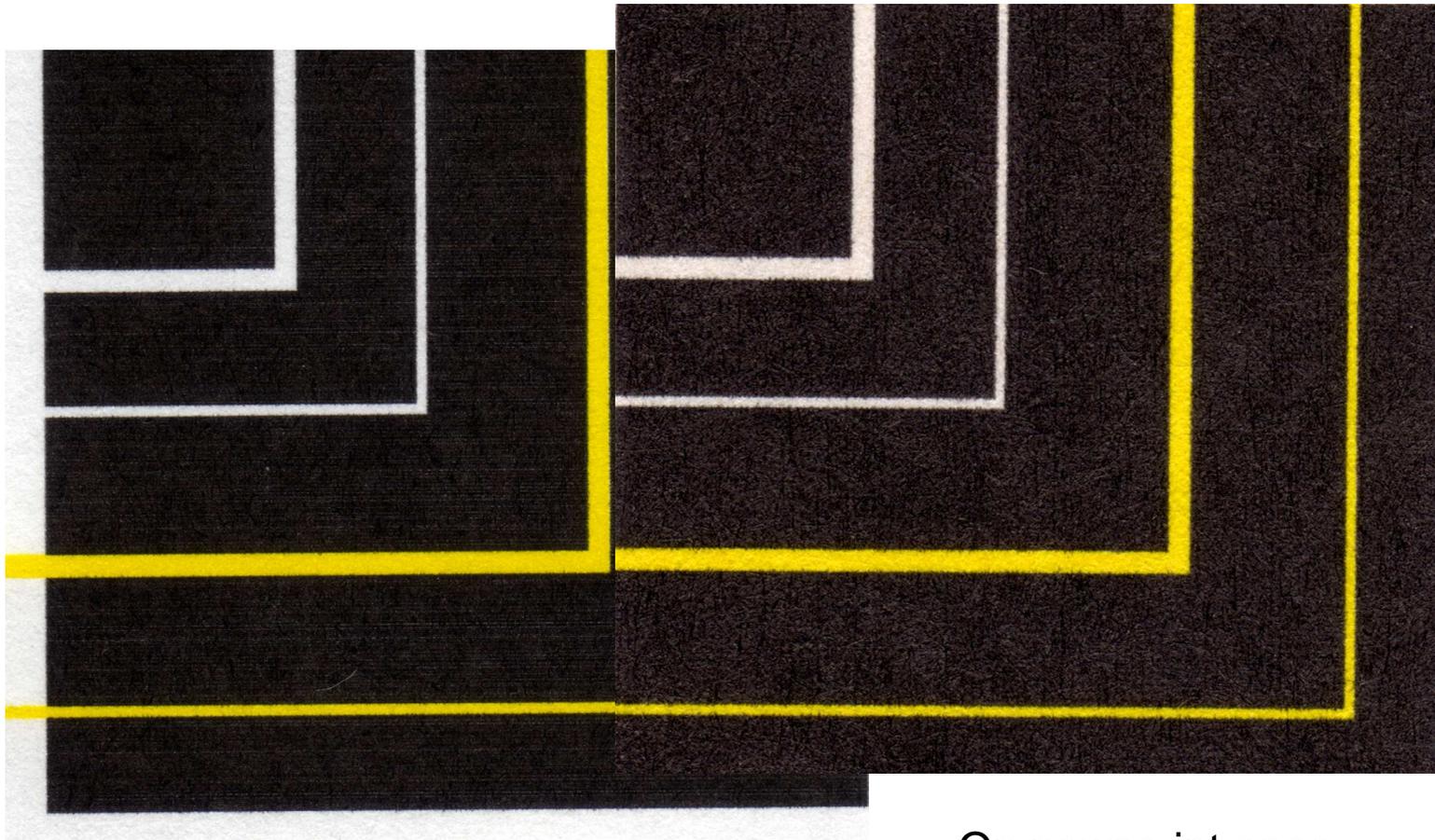
\*Normalized Wet Smear =  $100 \times (\text{smear OD}) / (\text{Maximum OD})$

# Effect of Treatment Type on Intercolor Bleed



ICB trend: Colorlok is always best. PR type improves all papers.

# Example of Intercolor bleed



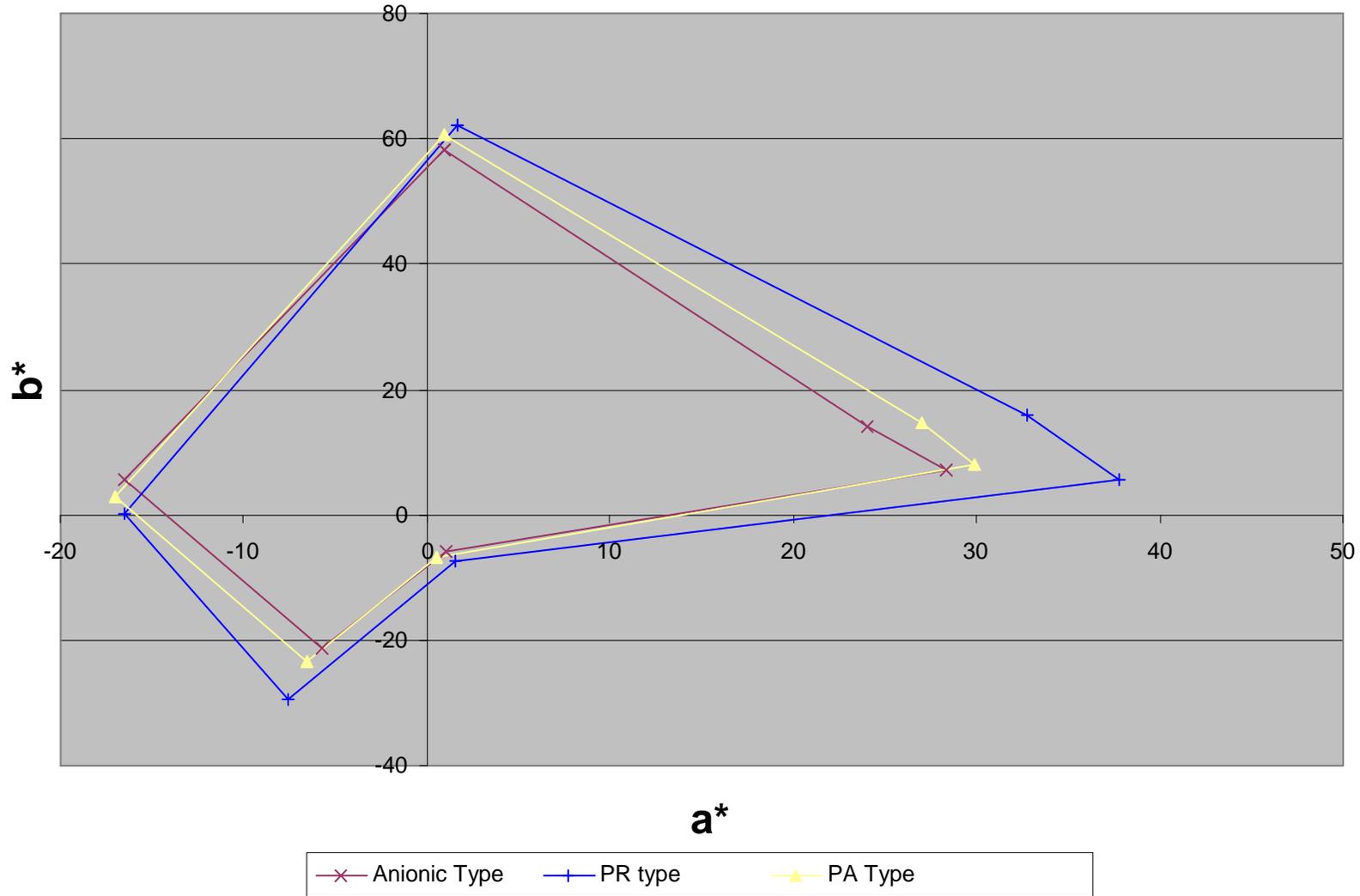
On Colorok paper  
(good)

On newsprint paper  
(poor,

movement of pigment along fibers)

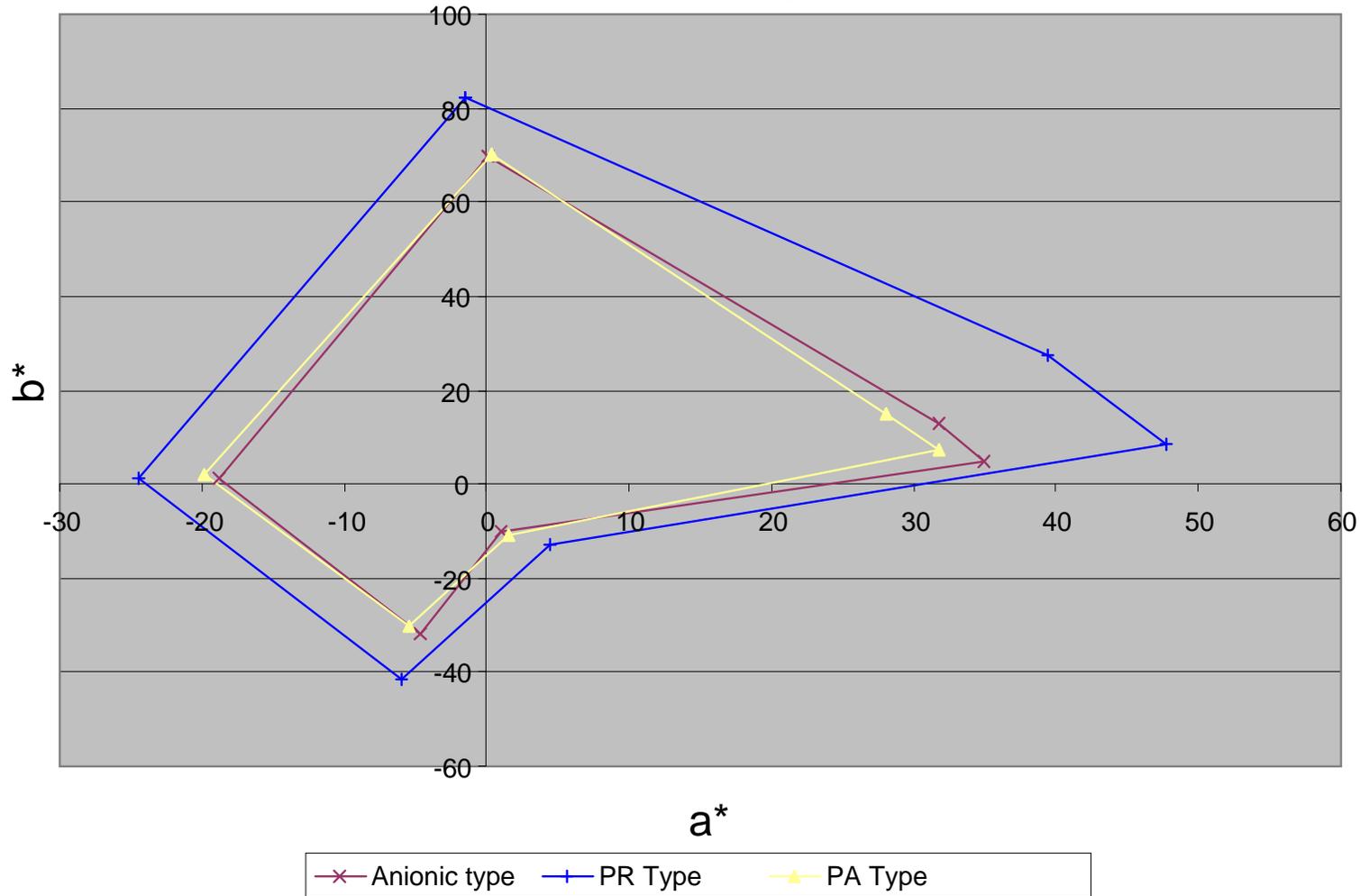
**Polymer attached pigment**

# Color Space-Newspaper



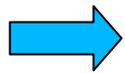
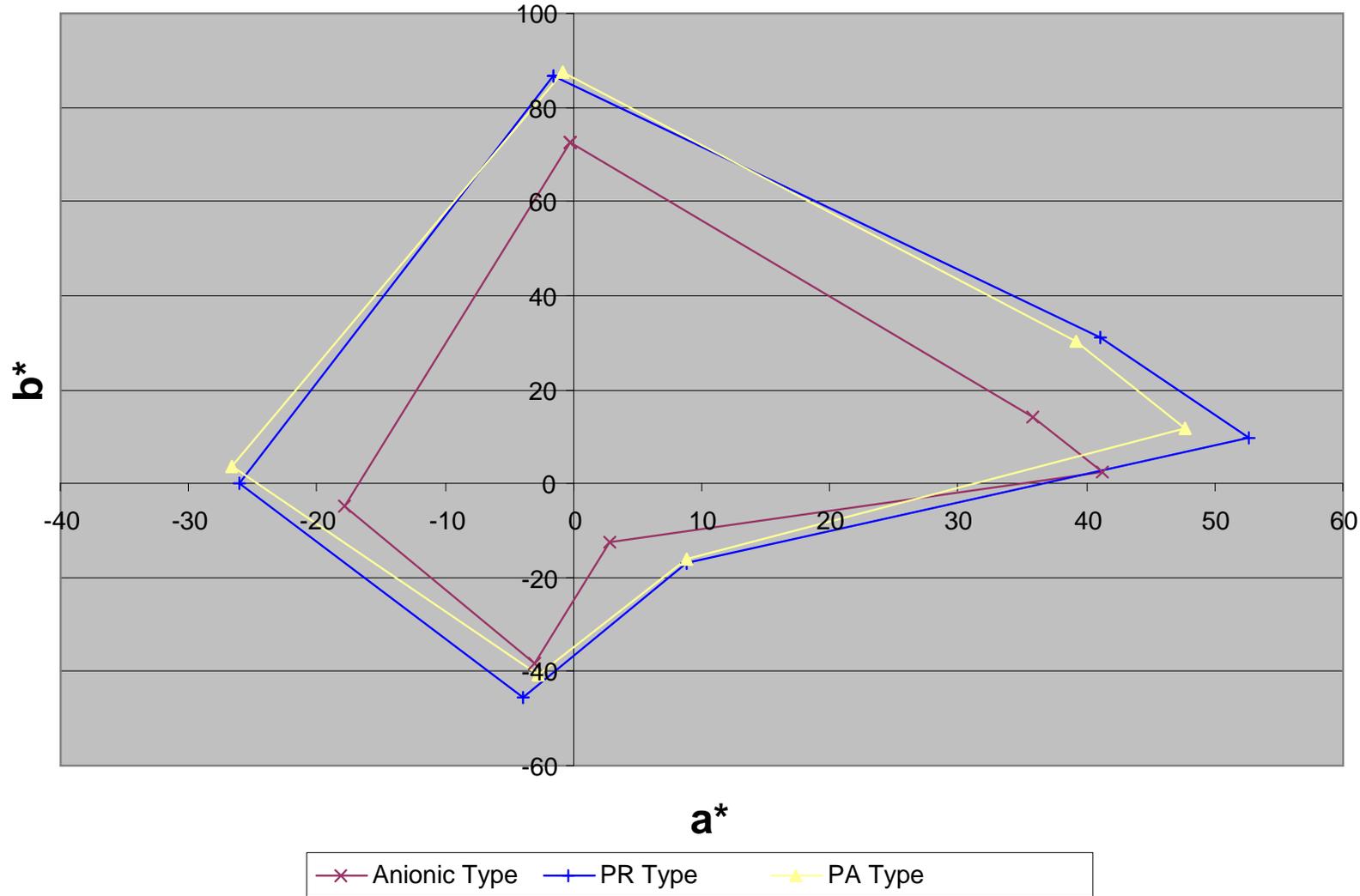
**Largest color gamut is with paper recognition treatments on the pigments. However, not a large difference because newsprint is poor quality paper.**

# Color Space-Xerox4200



**Again, largest color gamut is with paper recognition treatments on the pigments**

# Color Space-HPMP



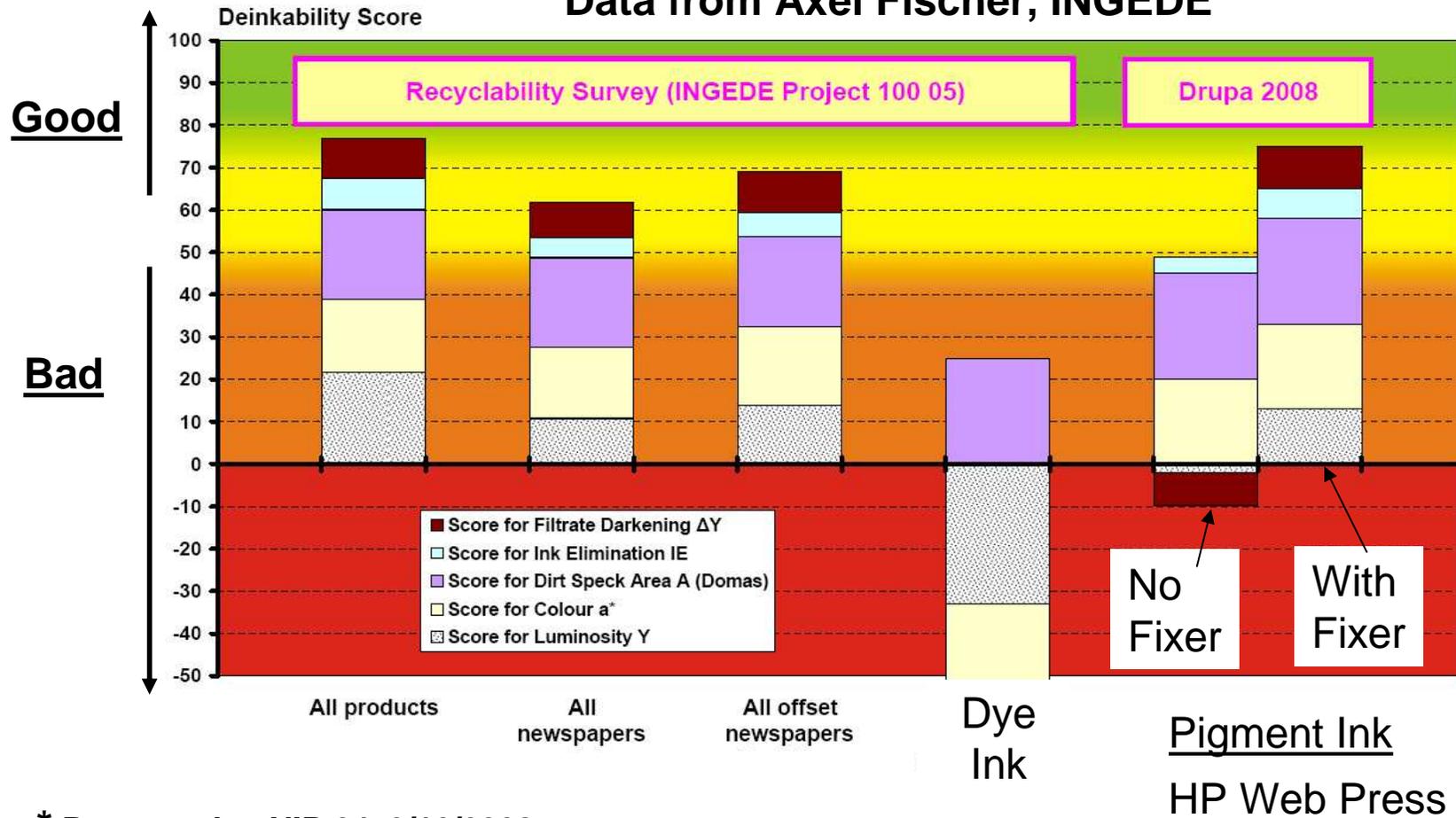
**Colorlok paper is best of all; anionic type treatment is still the smallest gamut.**

## Deinkability/Recyclability

- Another important consideration of the ink/media interaction is the impact on deinkability/recyclability.
- Reducing the environmental impact of inkjet requires that the prints be compatible with existing recycling operations.
- This is especially true for the printing of newspapers and magazine – both of which are target segments for inkjet presses.

# Pigmented Ink with Fixer can have good Recyclability:

\*Data from Axel Fischer, INGEDE



\* Presented at NIP 24, 9/10/2008

# Summary Table

	<u>Pigment type</u>			<u>Fixer</u>
	Anionic	Paper Recognition	Polymer attached	
OD	o	+	-	+
Durability (smear and water)	o	-/+	+	-
Color Gamut	o	+	+	+
Recyclability	?	?	?	+
Intercolor Bleed	o	+	-	+

# Conclusions

- Pigments which are commonly used in inkjet printing can be surface treated via Cabot's diazonium chemistry to provide a variety of functions.
- Improvements in OD, color gamut and intercolor bleed can be achieved when the surface treating agent is comprised of chemical groups which directly interact with the paper.
- This interaction is further enhanced when fixers are used in the paper.
- Durability improvements can be achieved when surface treatments include the attachment of polymeric groups, however, additional formulation approaches would be needed to break the tradeoff of durability and OD

# Cabot's Views of Colorants for High Speed Commercial Printing

- Aqueous *pigmented* ink will dominate as IJ takes more shares from Offset printing.
- Optimizing for *all* aspects of high speed commercial printing, ie, OD, durability, color gamut and recyclability should be possible by the judicious selection of surface modified pigments in combination with appropriate fixers and ink additives.
- Surface modified pigments, because they are 'self dispersed', offer a wide latitude for ink formulation for which additives can be used to improve the print performance.
- Similarly, these *self dispersed* pigments are very colloiddally stable and are likely to provide the printhead reliability properties required for high speed inkjet printing.