35º Congresso e Exposição
Annual de Celulose s Papel

Precipitated Calcium Carbonate for Coated Papers

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MINERALS TECHNOLOGIES
Specialty MINERALS

Learning Objectives

Participants will be able to:

- **Describe the major classes of coating grade PCC**
- **Differentiate filling from coating PCC**
- **Determine the impact of PCC physical characteristics on coating performance**

Synthesis of PCC

- **Lime/soda process**
- **Ammonium chloride process**
- **Lime/CO_2 (carbonation) process**
  - **Process used in satellite plants**

Lime/CO_2 Process

- $CaCO_3$ ➡ $CaCO_3$

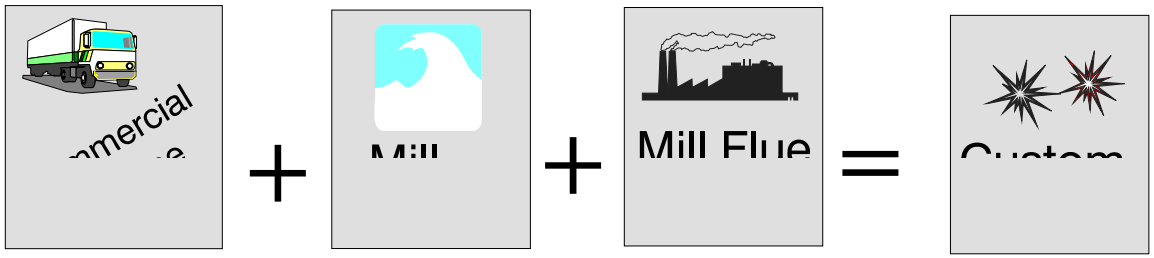
- "Milk of Lime" (slake) production:
  - $CaCO_3$ + heat ➡ $CaO + CO_2$
  - $CaO + H_2O$ ➡ $Ca(OH)_2$

- Carbonation step:
  - $Ca(OH)_2 + CO_2$ ➡ $CaCO_3 + H_2O$

Carbonation Process Control

- **Crystal size and shape controllers:**
  - **Reaction rate**
  - **Concentration**
  - **Temperature**
  - **Agitation**
  - **Chemical additives**

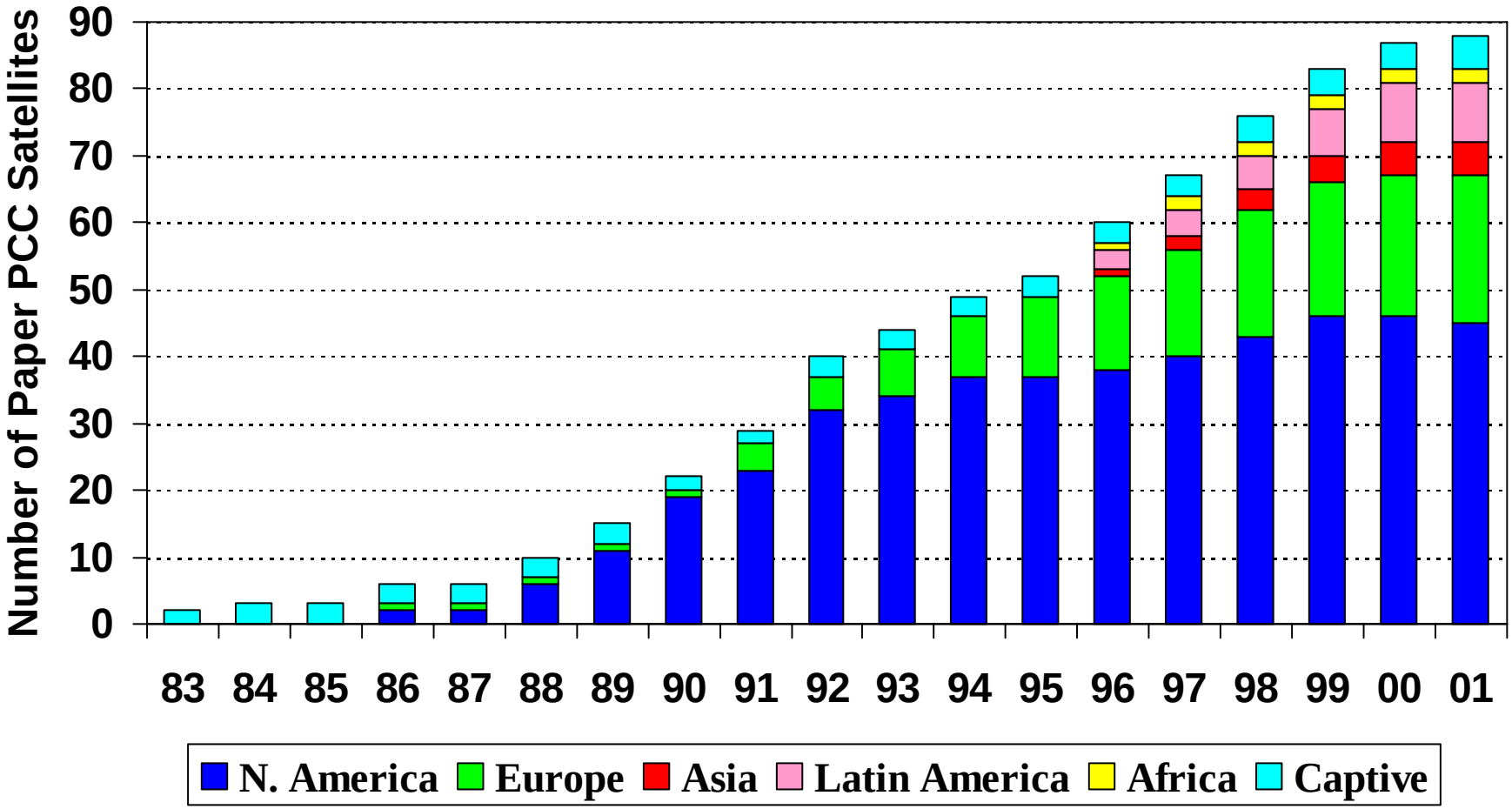
Satellite Plant Concept



- **Location at Mill site permits:**
  - **Tailored products**
  - **On-demand delivery**
  - **No freight costs, no railcar unloading**
  - **No settling issues**

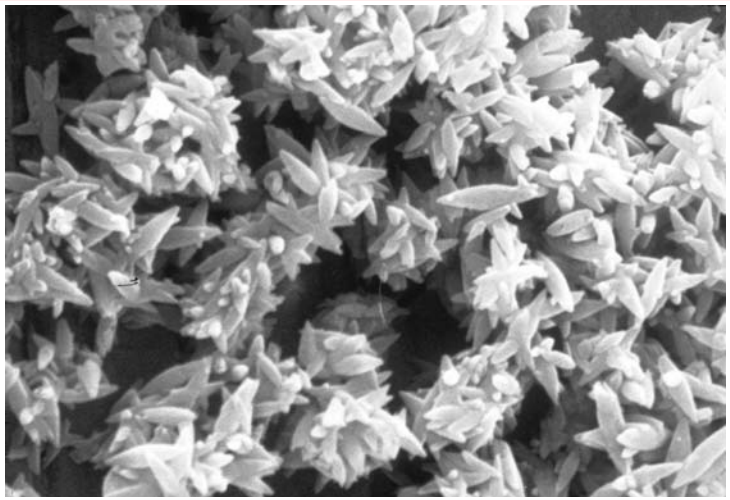
PCC Satellite Plants

Global Installations – Filling and Coating

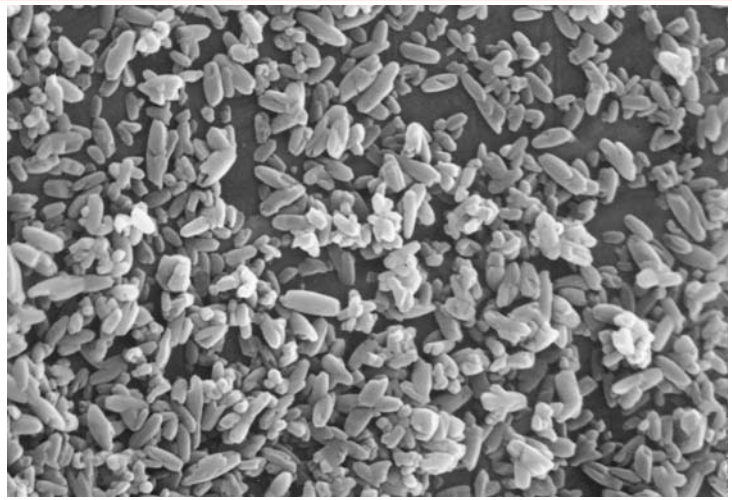


Source: RISI

Filling vs. Coating PCC



- **Filling Grade PCC**
  - Open structure
  - Low solids
  - Typically undispersed
  - Calcite/aragonite



- **Coating Grade PCC**
  - Solid, closed structure
  - High solids
  - Typically anionic
  - Calcite/aragonite

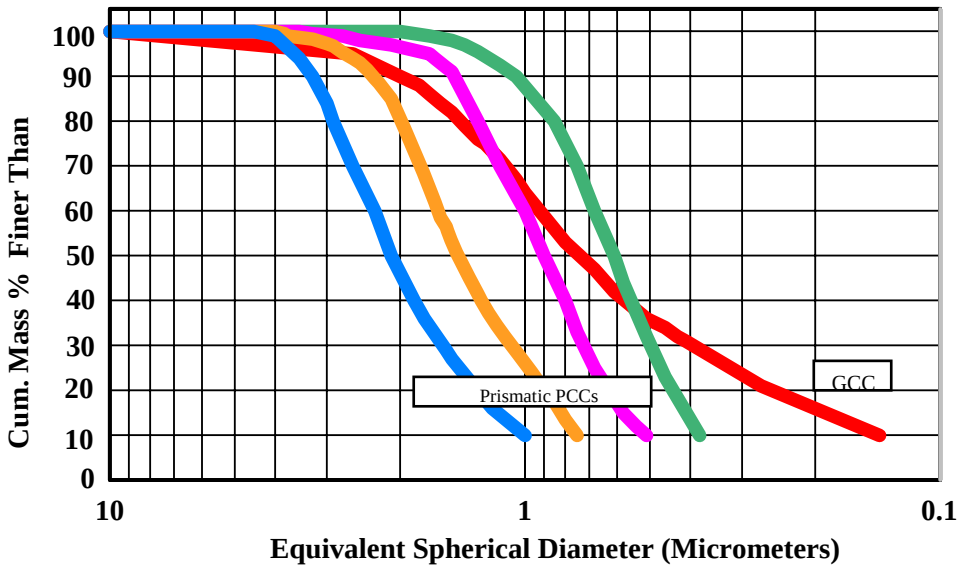
“Five Degrees of Freedom”

- **The performance of PCC in coating is determined by:**
  1. **Particle size**
  2. **Particle size distribution**
  3. **Surface area**
  4. **Particle shape (morphology)**
  5. **Surface chemistry/dispersion**

Particle Size Distribution (PSD)

- **Range of average particle sizes available**
  - 0.40 to 2.50µ (prismatic calcite)

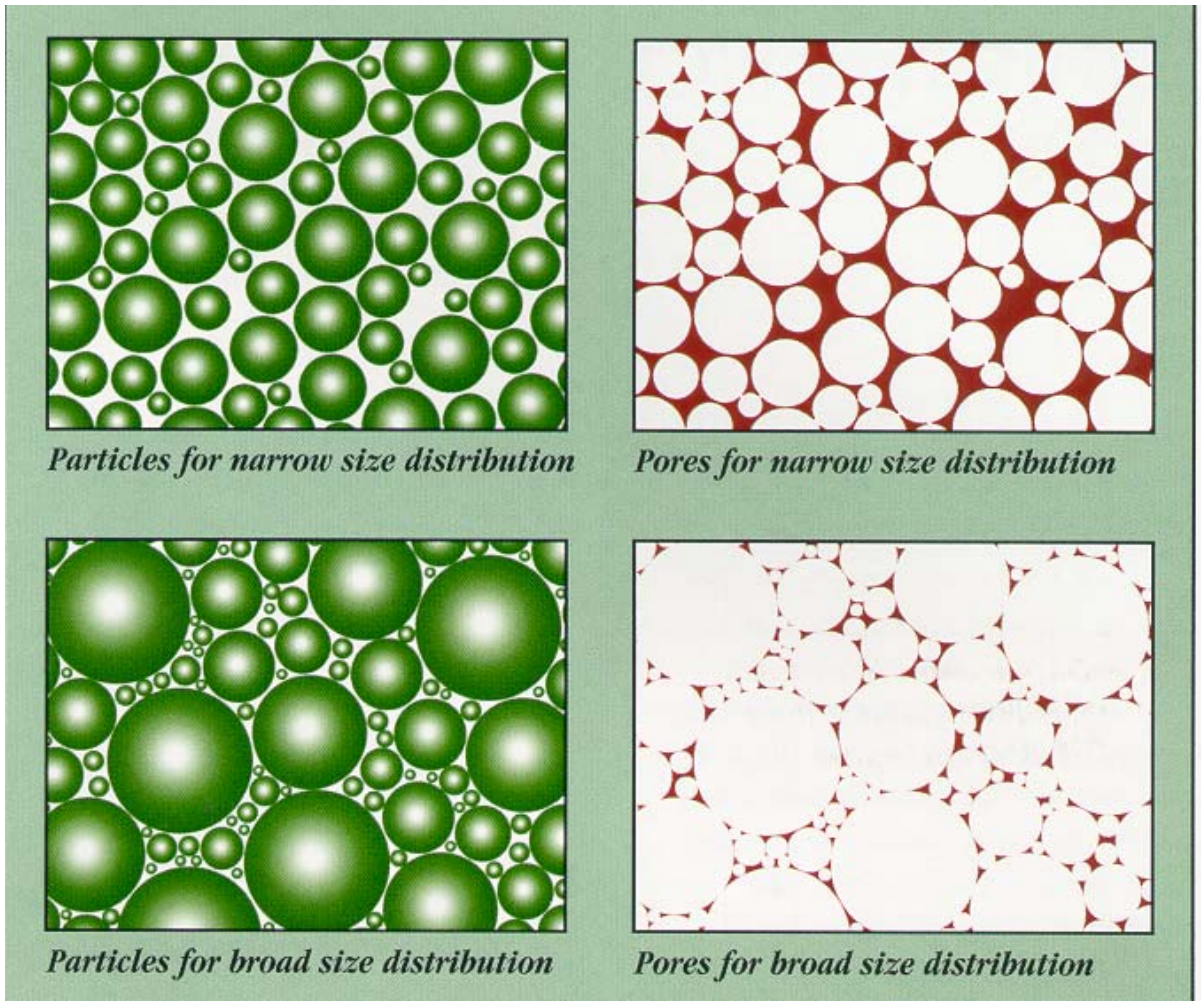
Geometric **S**tandard **D**eviation (GSD) = $(D84/D16)^{1/2}$



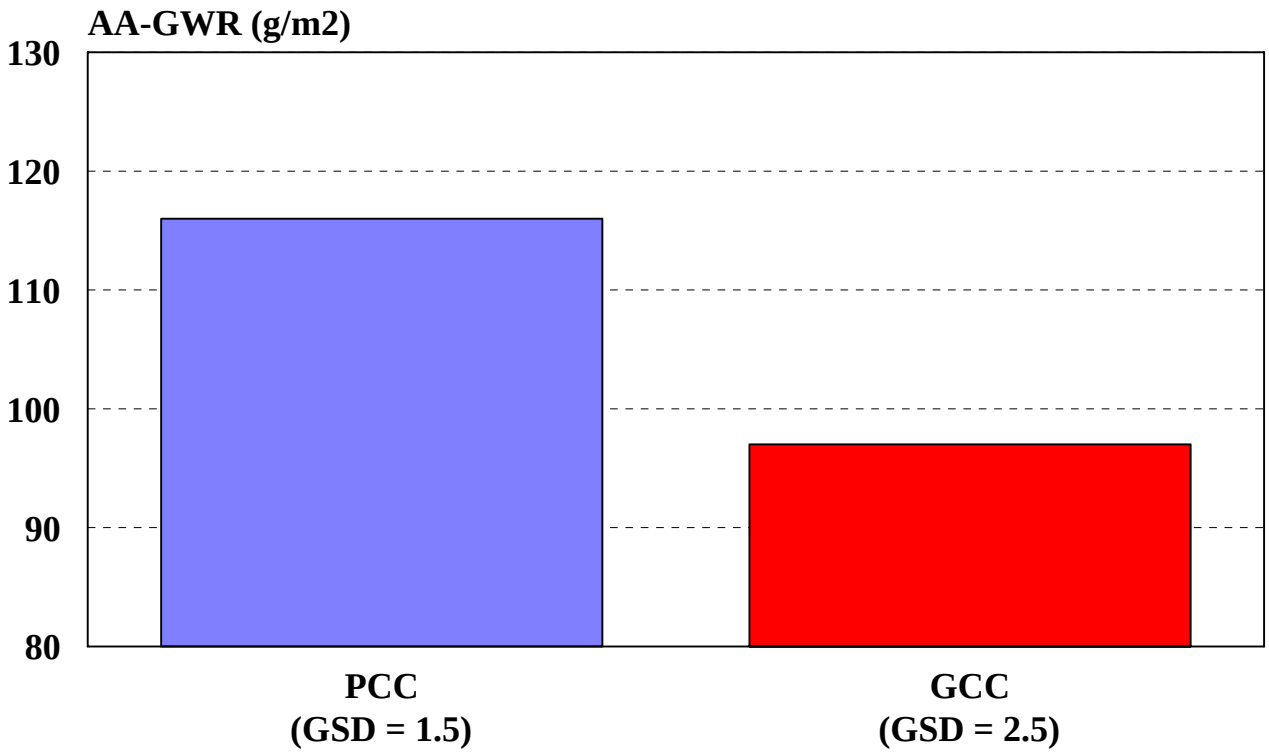
PCC GSD = 1.5-1.8

GCC GSD = 2.0-2.5

Effect of PSD on Coating Layer Void Structure



Effect of Narrow PSD on Dewatering Rate of Coating

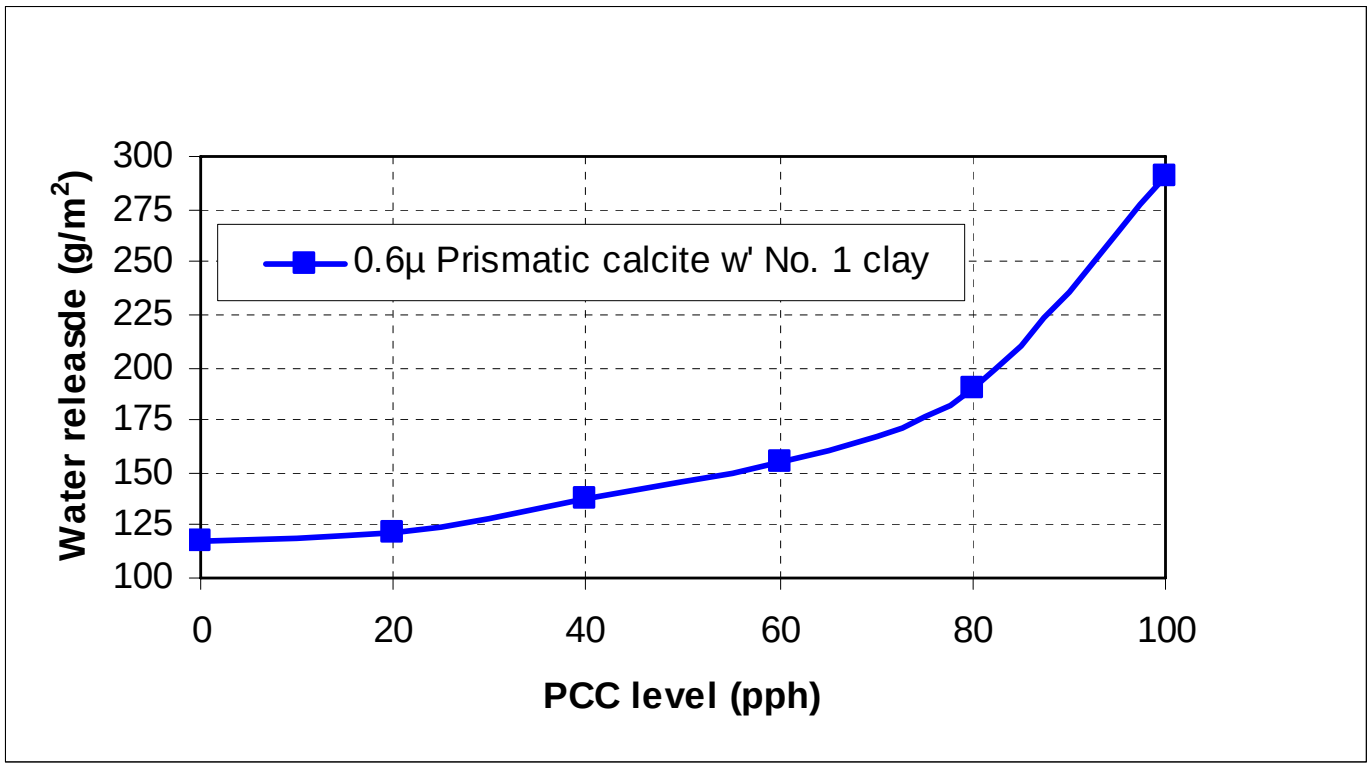


50 $CaCO_3$/50 Clay

12/2 Latex/starch

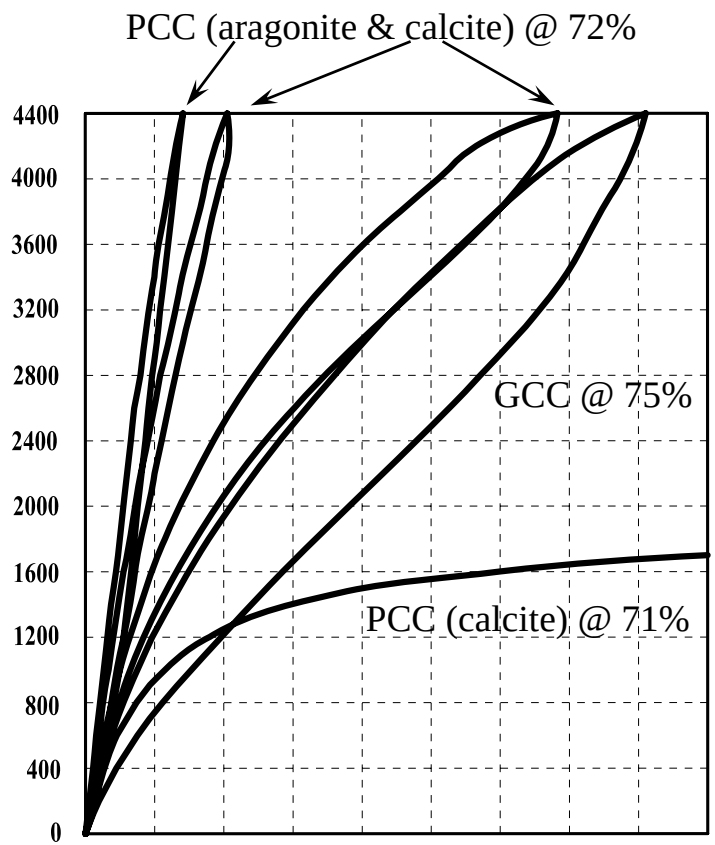
Dewatering As a Function of PCC Content - 0.6µ Prismatic Calcite

- **Small amount of clay very beneficial**



PCC Solids/high Shear Viscosity Relationship

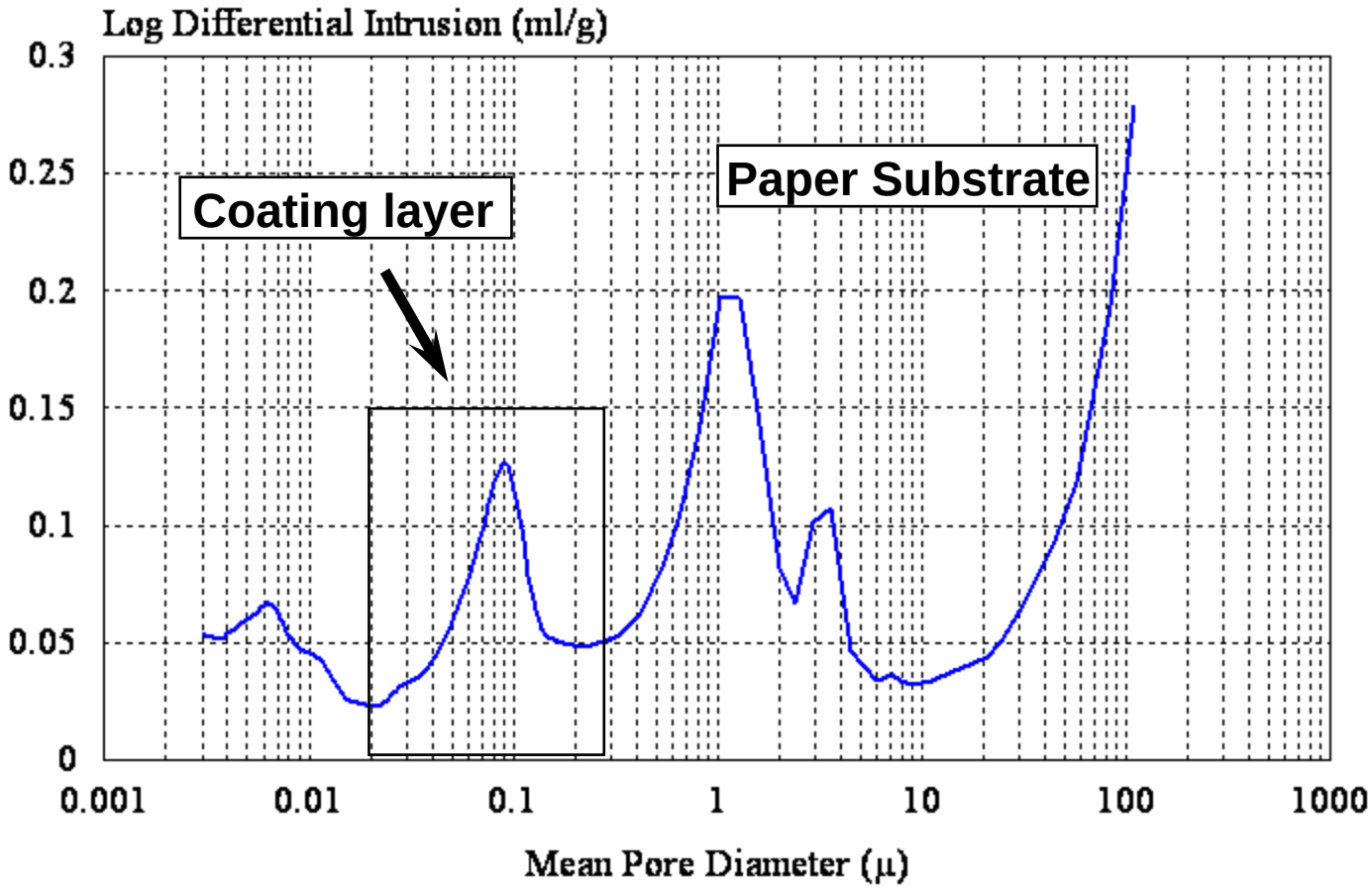
- **PCC's high shear viscosity is variable**
- **Heavily dependent on post-precipitation processing.**



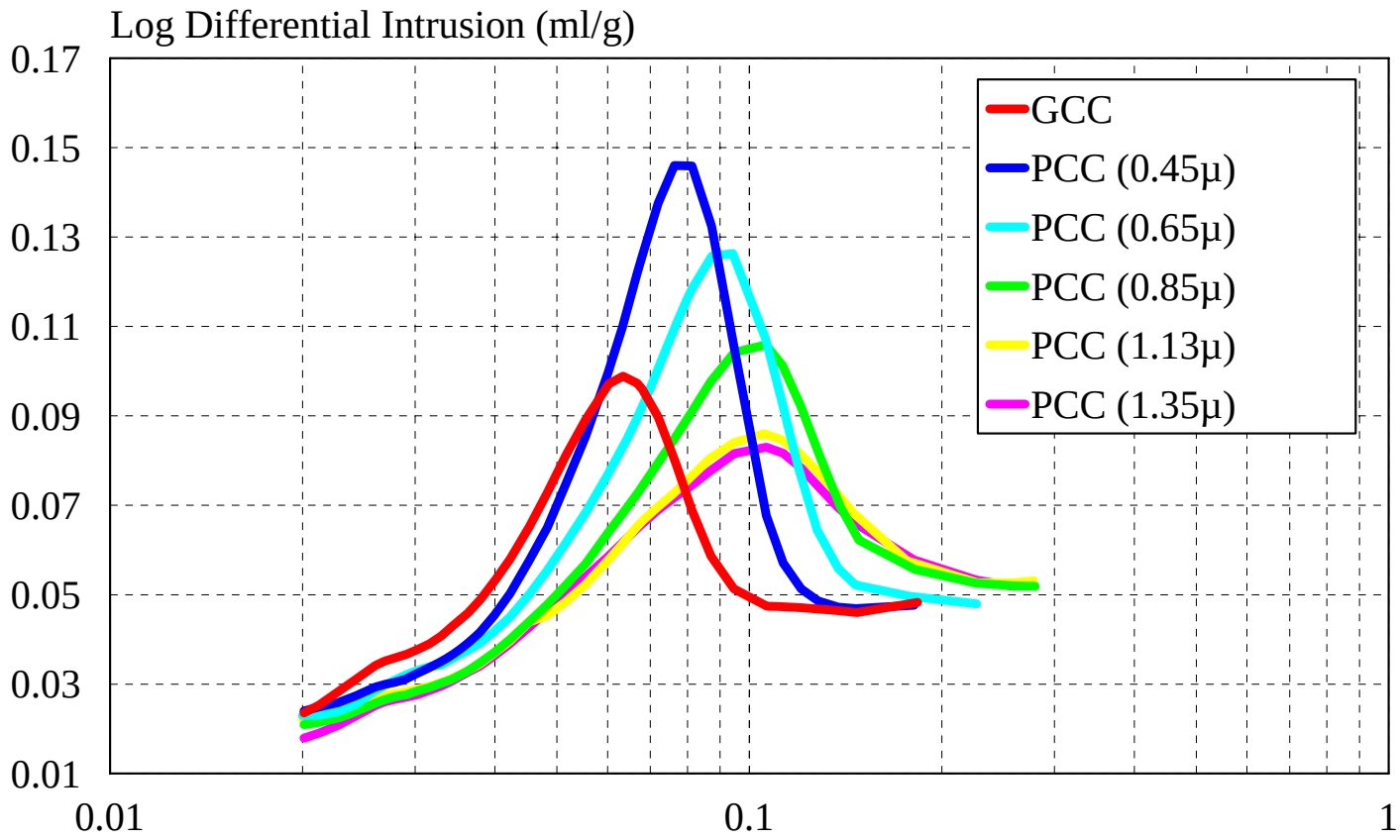
Using PCC in Coating

- **Effect on coating colors:**
  - **Lower Brookfield viscosity**
  - **Intermediate high shear viscosity**
  - **Intermediate application solids**
  - **Faster coating color dewatering**
  - **Intermediate binder demand**
  - **Easier drying**

Mercury Intrusion Porosimetry

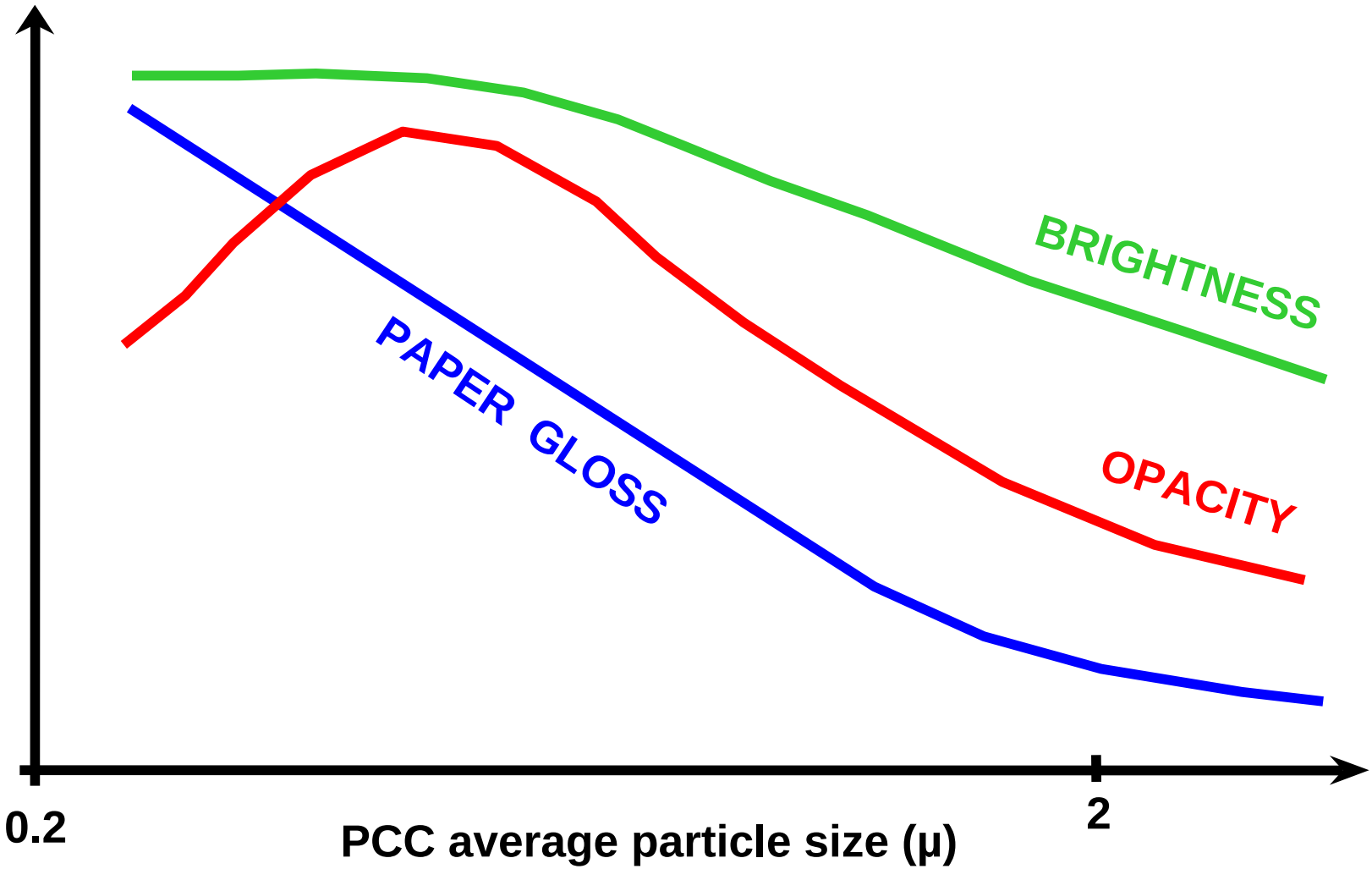


Variation in Coating Pore Structure



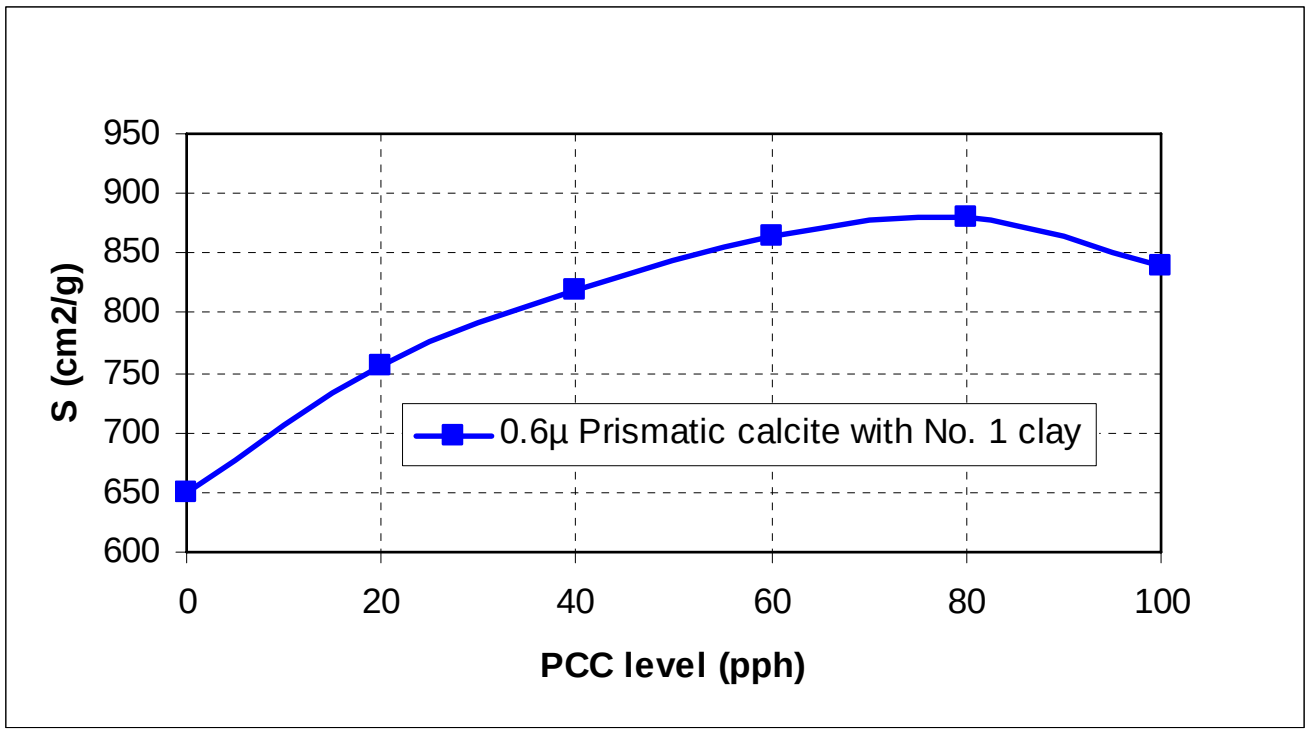
50 $CaCO_3$/50 Clay
12/2 Latex/starch

Effect of PCC size on Optics

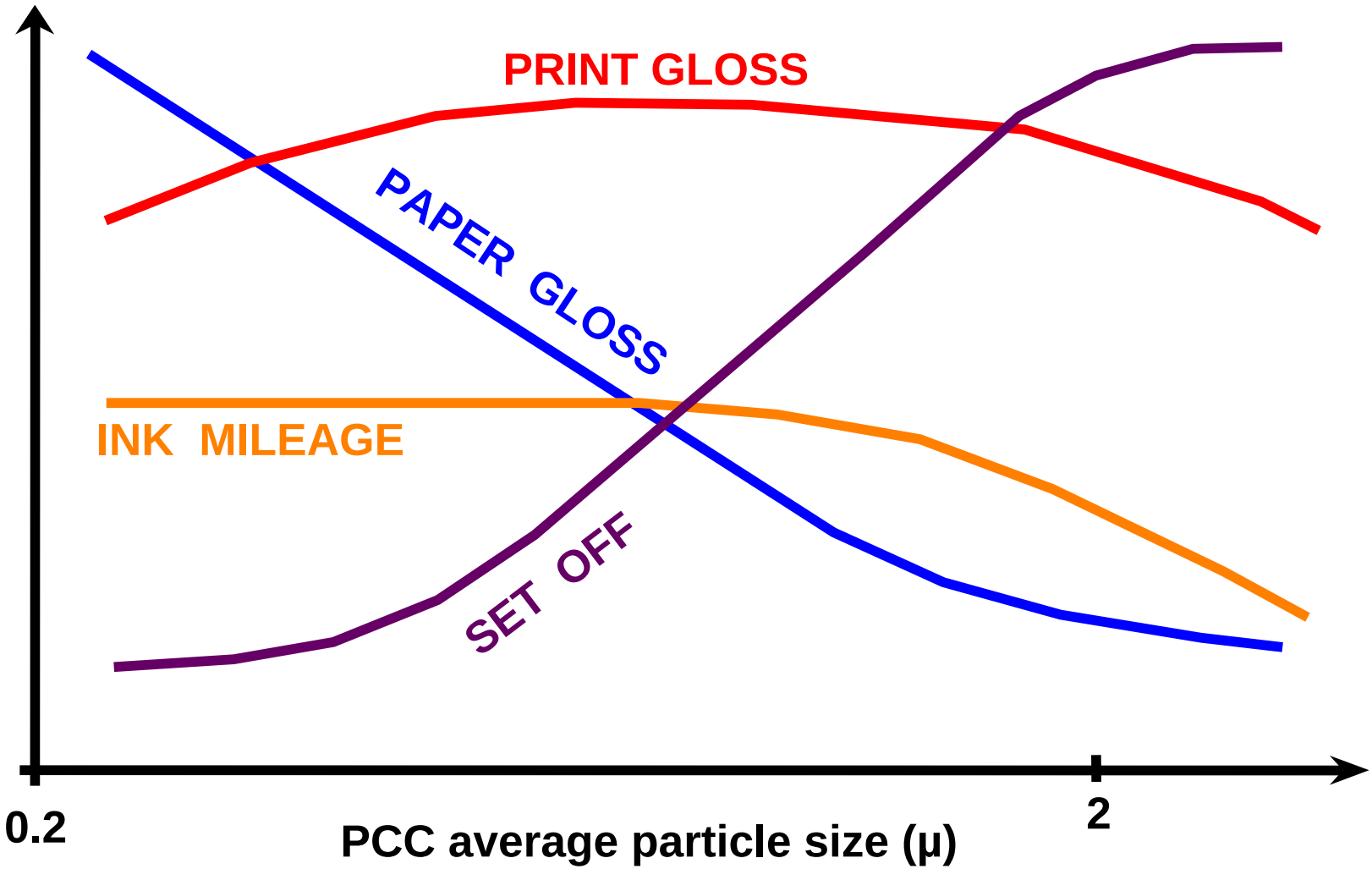


Optimum scattering found at specific clay/carbonate ratios

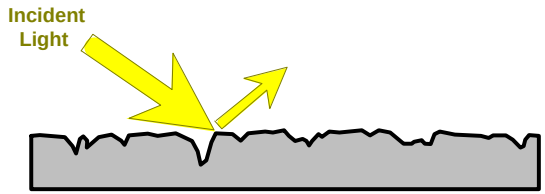
- Scattering peaks at ~ 80 part level



Effect of PCC size on Print Properties



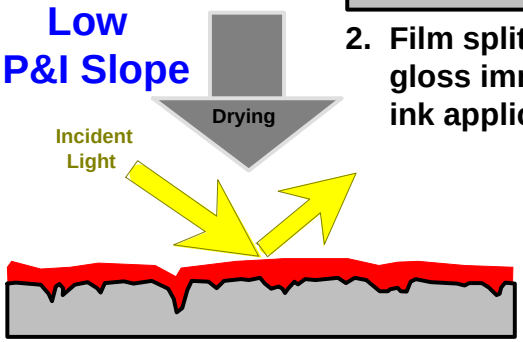
A Proposed Mechanism for Printed Gloss



1. Paper gloss determined by paper roughness.

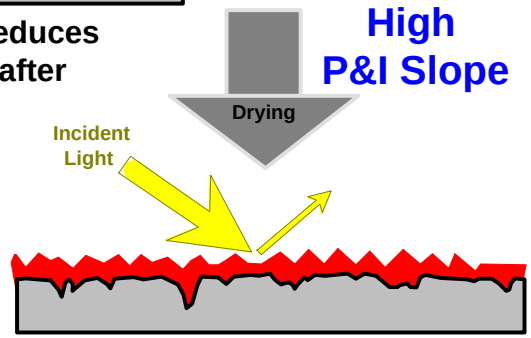
2. Film split pattern reduces gloss immediately after ink application.

Low P&I Slope



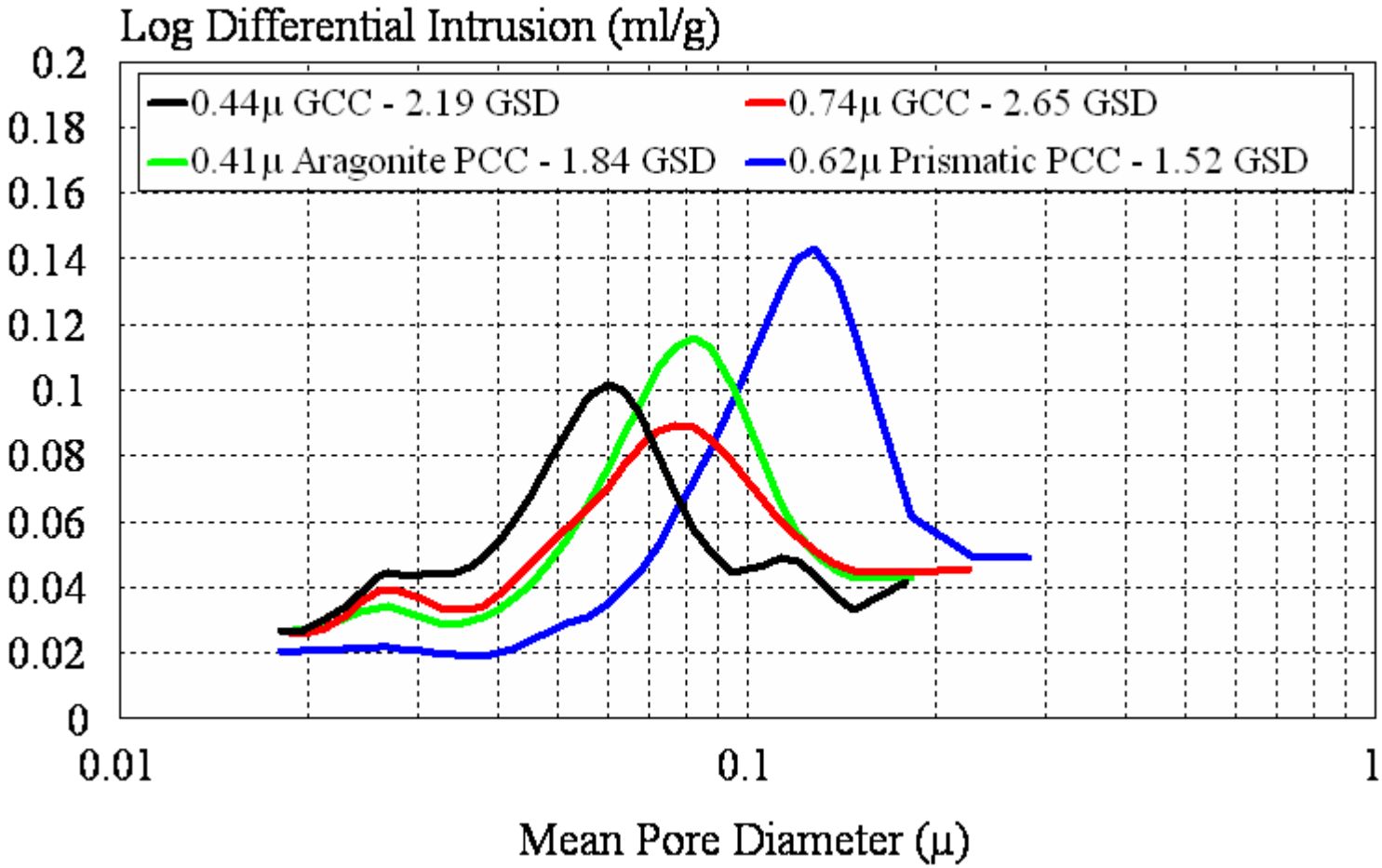
3. During normal ink drying, the pattern relaxes and the ink surface becomes smoother and glossier than the paper.

High P&I Slope



4. Rapid ink solvent removal hardens the film before the split pattern relaxes. Ink gloss remains below paper.

Pore Structure Affected by Carbonate Choice



(80/20 $CaCO_3$/No. 1 clay systems 12 pph SB latex 0.7 pph CMC)

Using PCC in Coating

- **Choice of Average Particle Size (APS)**
  - **Control of Sheet Gloss - Matte, Dull, Gloss**
  - **Blends for control of pore structure and print performance**
- **Low Surface area for a given APS**
  - **Excellent Print Gloss**
  - **Positive impact on binder demand**
  - **Good runnability**

Using PCC in Coating

- **Effect on coated sheet performance:**
  - **Good fiber coverage/smoothness**
  - **Higher opacity**
  - **Higher brightness**
  - **Higher porosity**
  - **Better blister resistance**
  - **Ink receptivity**
  - **Faster ink set rate/lower set-off**

PCC in Woodfree Grades

- **When replacing conventional GCC:**
  - **Use an equal amount of appropriately-sized PCC**
  - **Maintain current binder level**
  - **Increase water-holding agent**
  - **Use care with acidic additives**
  - **Determine solids/viscosity relationship**

PCC in Groundwood Grades

- **When replacing Clay blends*:**
  - **Start with 40% high gloss PCC in formulation**
  - **Raise solids level 2-3% and determine solids/viscosity relationship**
  - **Use care with acidic additives**
  - **Determine potential for reducing higher cost pigments**

* Such as a 3:1 blend of delaminated and No. 2 clay

Coating Grade PCC Is ….

- **Flexible - control of process offers a variety of products tailored to meet specific needs**
- **Different from filling grade PCCs in structural form (often)**
- **Able to affect/control the pore dimensions generated in the coating structure**
  - **Influence optical and printability performance**