The Basics of Water-Based Barrier Coatings

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Spring Meeting

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Outline

- Define a Barrier Coating
- Describe the types
- What are the applications
- How are they applied
- Testing and evaluation

What Is a Barrier Coating?

- A category of functional coatings
  - Friction control
  - Release properties
  - Abrasion resistance
  - Barrier properties (light, oil, water, O_2…)
  - And others…

Barrier Characteristics

Impart end-use properties to the sheet

- Penetration resistance
  - Grease
  - Oil
  - Liquid water
- Penetration control
  - Water vapor (MVTR)
  - Oxygen (or other gas)

Product Types

- Polymers
  - Wax (cascade, curtain, WIM)
  - PE (extruded)
  - FC
- Water-based
  - Acrylic
  - Modified PET – EvCote® branded chemicals
  - PVAc
  - PVDC

A Word on FC's

- Perfluorooctanoic acid (PFOA; C8) enviro and biologic accumulation
- Slow/negligible deterioration
- No harmful effects documented, but .....
- Thus, alternative barrier chemistries are being evaluated

The Market Is Changing

- FC's becoming less popular
- Oil and gas prices up; wax and PE follow
- A "green" movement: Wal-Mart, Starbucks, Coors, Coca-Cola
- Alternative technologies now being evaluated

Where Are Barrier Coatings Used ?

Primarily packaging

- Industrial
  - Parts, usually shipped with oil or grease
  - Water resistant wraps, electronics
- Food
  - Pizza, fast food, pet food, popcorn
  - Frozen foods
  - Meats/poultry/vegetables (water, grease & oil)
  - Hot and cold drink cup

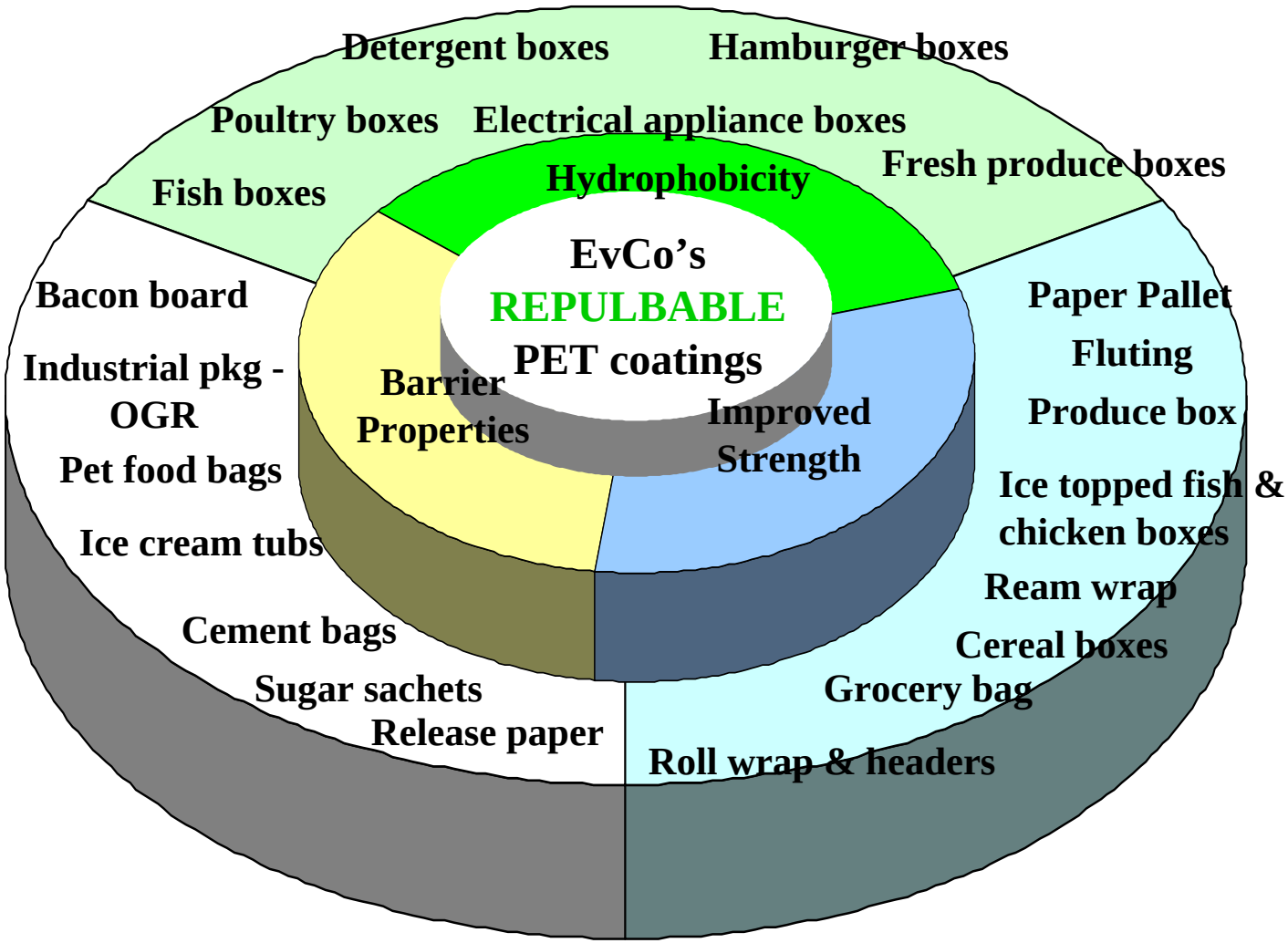
Another Way to Look at It…

Product life cycle

- Long term (>1 day)
  - Shipping, storage, frozen food, pet food, industrial applications
- Short Term (typically < 1 hour)
  - Pizza, fast food, popcorn
  - Hot and cold drink cup

Applications are tailored to need and product cycle

Potential Areas of Application



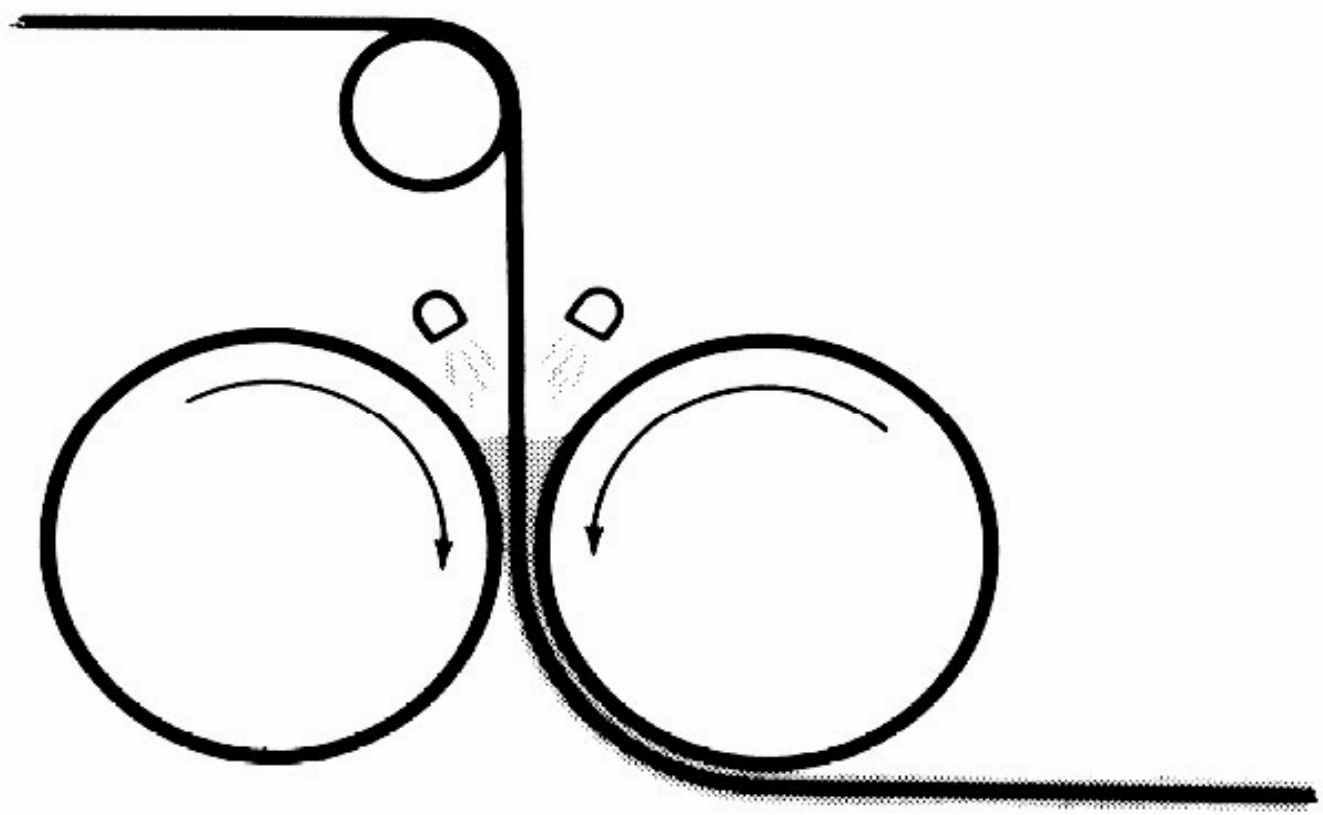
Application Options

- Application methods
  - Conventional size press
  - Coaters (rod, blade and air-knife coaters, on- and off-line)
  - Gravure and flexo printers
  - Spray bar
  - Wet end
- Applied with or without penetration depending on demand
- Paper/board needs to be dried/cured?

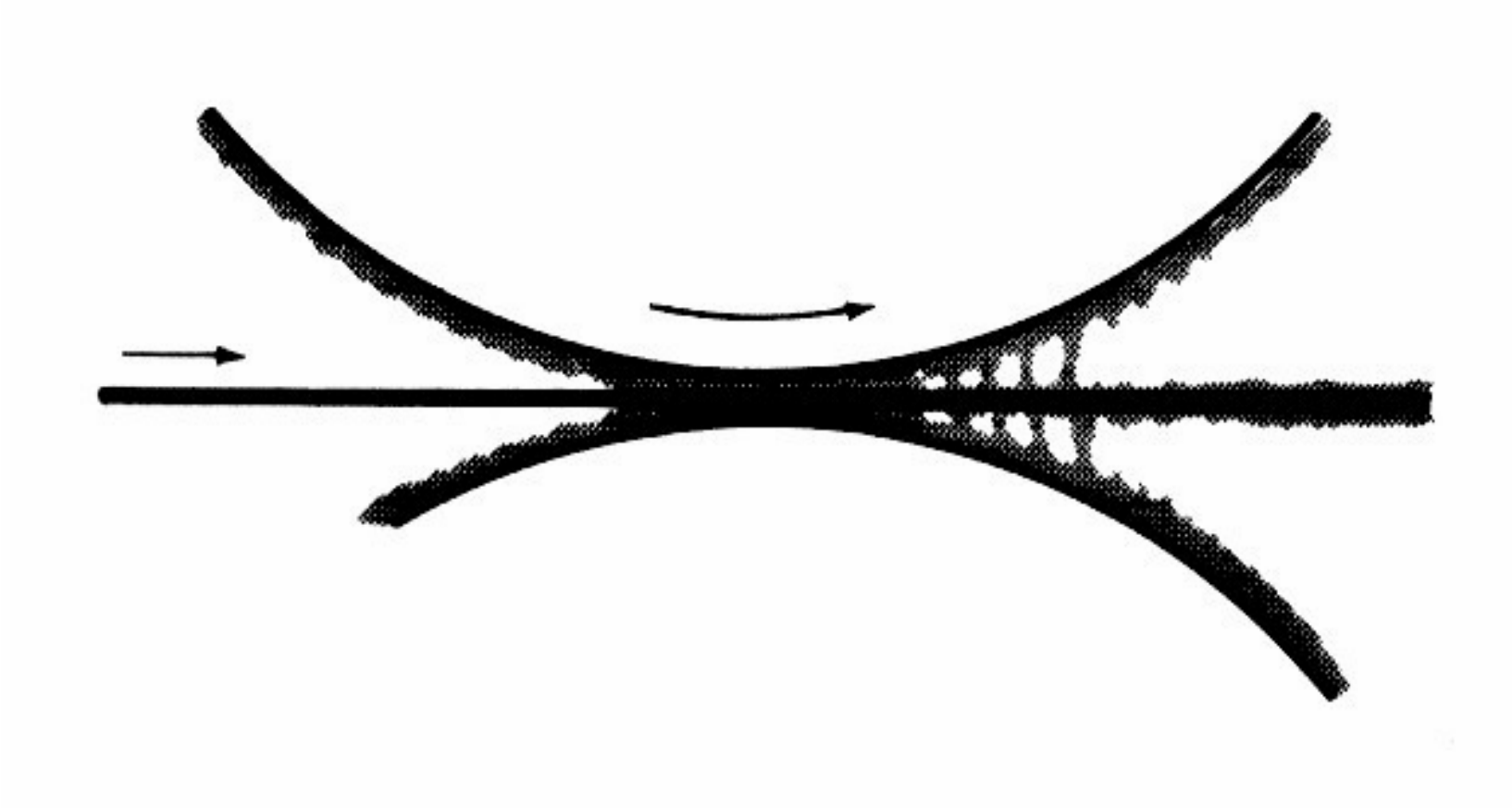
Application

- Wet end of paper machine
  - Retention is a concern
  - Interaction with wet end programs
- Size press
  - Puddle or pre-metered size press
  - Insuring even coverage
  - Pinholes a problem
  - Pickup and holdout

Puddle-type Size Press
Horizontal, 2-side Treatment



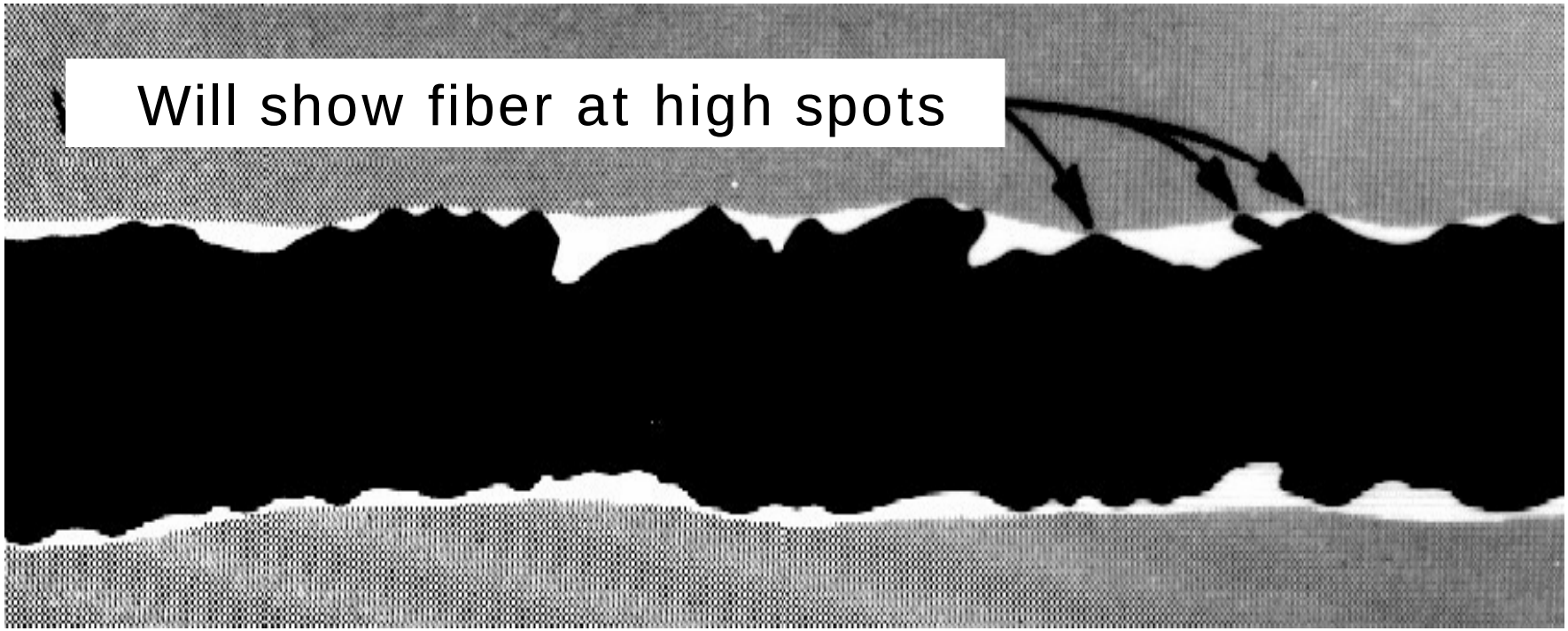
Film Split



Application

- Blade coater (rigid or bent)
  - Film integrity
- Spray coated
  - Film thickness, spray design
- Rod coater
  - Better than blade
- Air Knife Coater
  - Contour coater
  - Air entrainment an issue (bubbles)

Blade coater

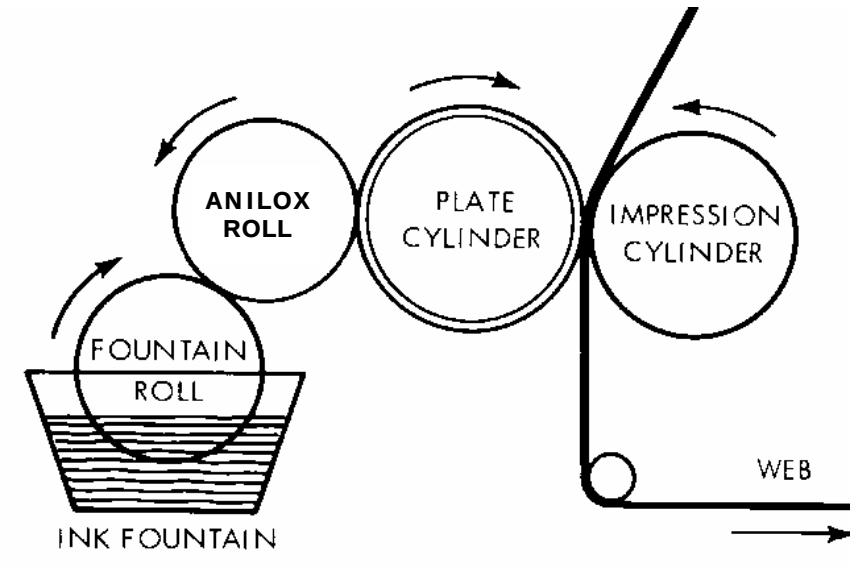


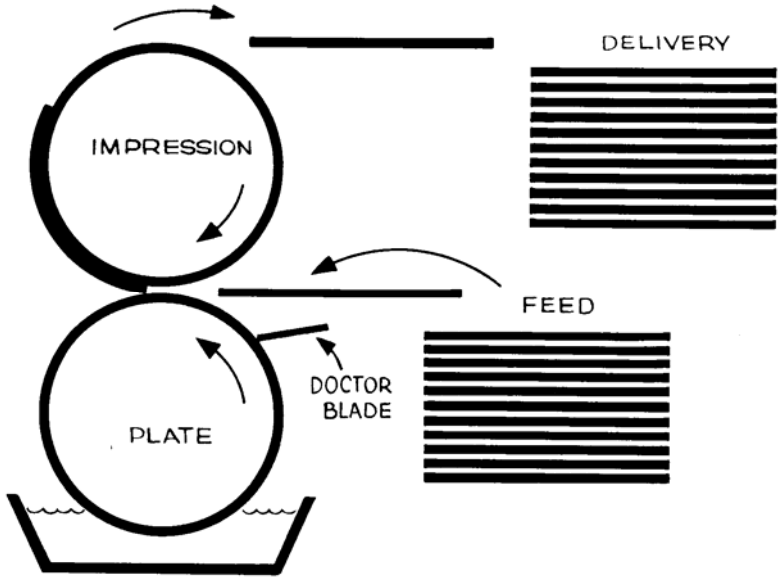
Achieving a continuous film is the challenge

Application

Press applied:

Gravure
- screen





Flexo
- solid area

Effect of Base Sheet

- Most typical substrates (board)
  - SBS/SUS
  - Coated recycled board
  - Liner
- Base sheet quality
  - Roughness (adverse – film integrity)
  - Porosity (holdout) denser is better
  - Degree of sizing (holdout)
  - Applying barrier over clay coating is a plus

Multiple coating layers

- Coat weight
  - Single versus multiple layer (bump)
  - Double bump more efficient
  - Cost
- Film integrity
  - Double layer = lower total coat weight
  - Same effect as single pass higher total coat weight

Aqueous Polymers

- Available as liquids or powders
- Stand alone or as a coating additive
- Some require additional preparation
- Many of the established aqueous coating considerations apply
- Press-applied materials may require surfactants or other additives

Aqueous Polymers

- Typically a milky (latex like) fluid
- Solids: 28% to 60%
- Application: 1.0 to 6.0 gsm
- Lend themselves to a number of application methods
- Variable low shear, usually high-shear stable
- Poor water retention in pure forms (low solids/viscosity)
- Good water retention (high solids/viscosity)

Formulation

- Size Press application
  - Starch typically the carrier
  - Pickup, holdout/penetration important
  - Quantity depends on final properties
- Coating (blade, rod, air knife)
  - Added to the coating formulation or used “as is”
  - Add towards the end of the batch
  - Quantity based on end use properties
  - Coat weight, holdout, film integrity important

Formulation

- Press application
  - Flexo
  - Rotogravure (film integrity issue)
  - Reverse rotogravure
  - Good control of application
  - Quantity depends on desired properties
  - Press station available?

Testing and Evaluation

- Liquid Water Resistance
  - Cobb Size (10+ minutes)
  - “Boat”, run to water penetration
- Oil and Grease Resistance (OGR)
  - 3M Kit test (range 1-12)
  - Higher the kit value, the greater the resistance
  - Purina, various types
  - Most customers/converters have their own tests

Testing and Evaluation

- Moisture Vapor Transmission Rate
  - MVTR, also WVTR
  - $(g/100in^2)/day$ or gsm/day
  - Standard Conditions
  - High temperature and humidity

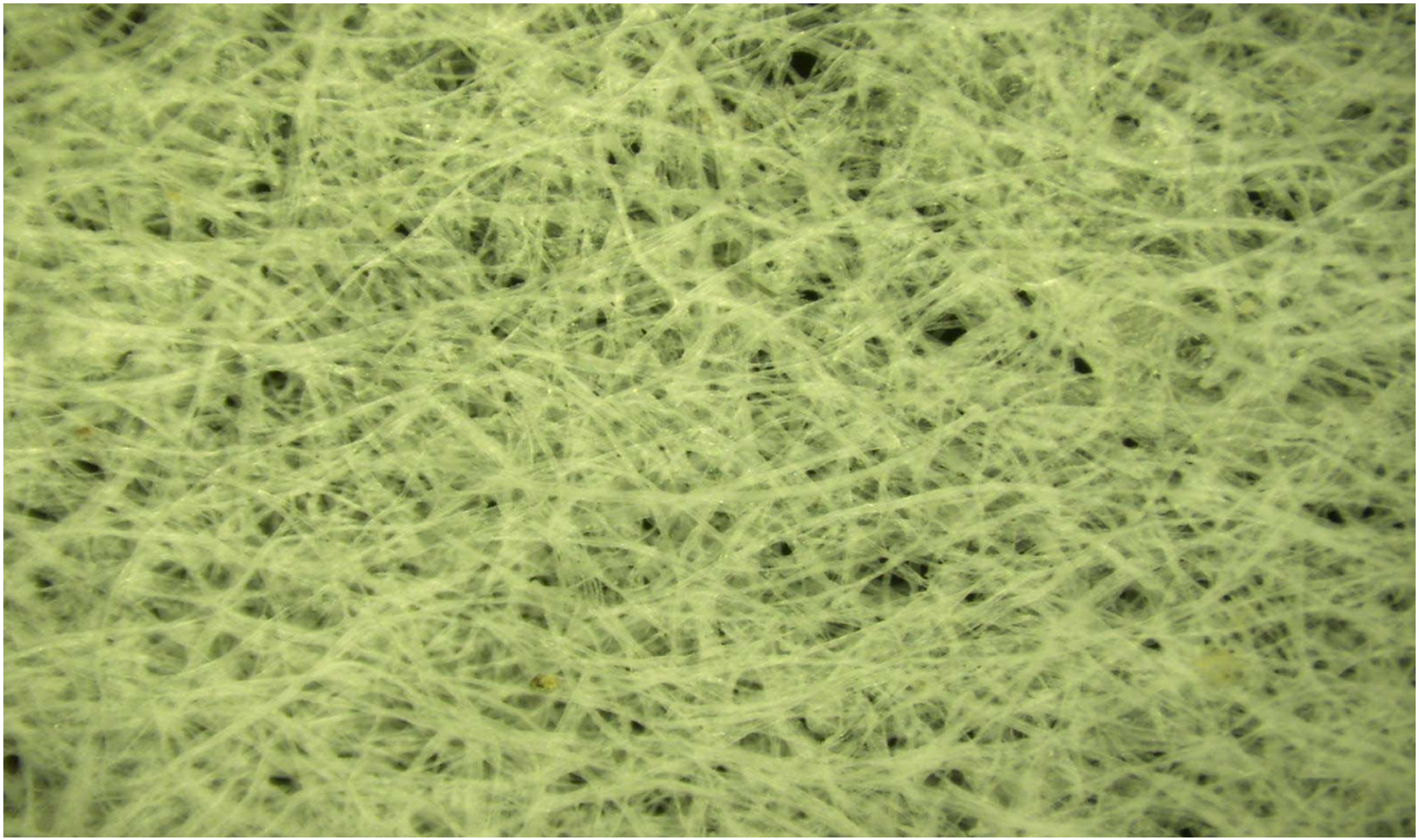
Testing and Evaluation
More Areas of Interest

- Scuff Resistance
  - Hot plate on a corrugator
  - Simulated with a hot iron drawn over the sheet
  - Heat can soften the coating
- Pinholes
  - Isopropanol puddle (visual)
  - May also dye the alcohol for visibility
  - Peanut, olive or vegetable oils
  - WD-40

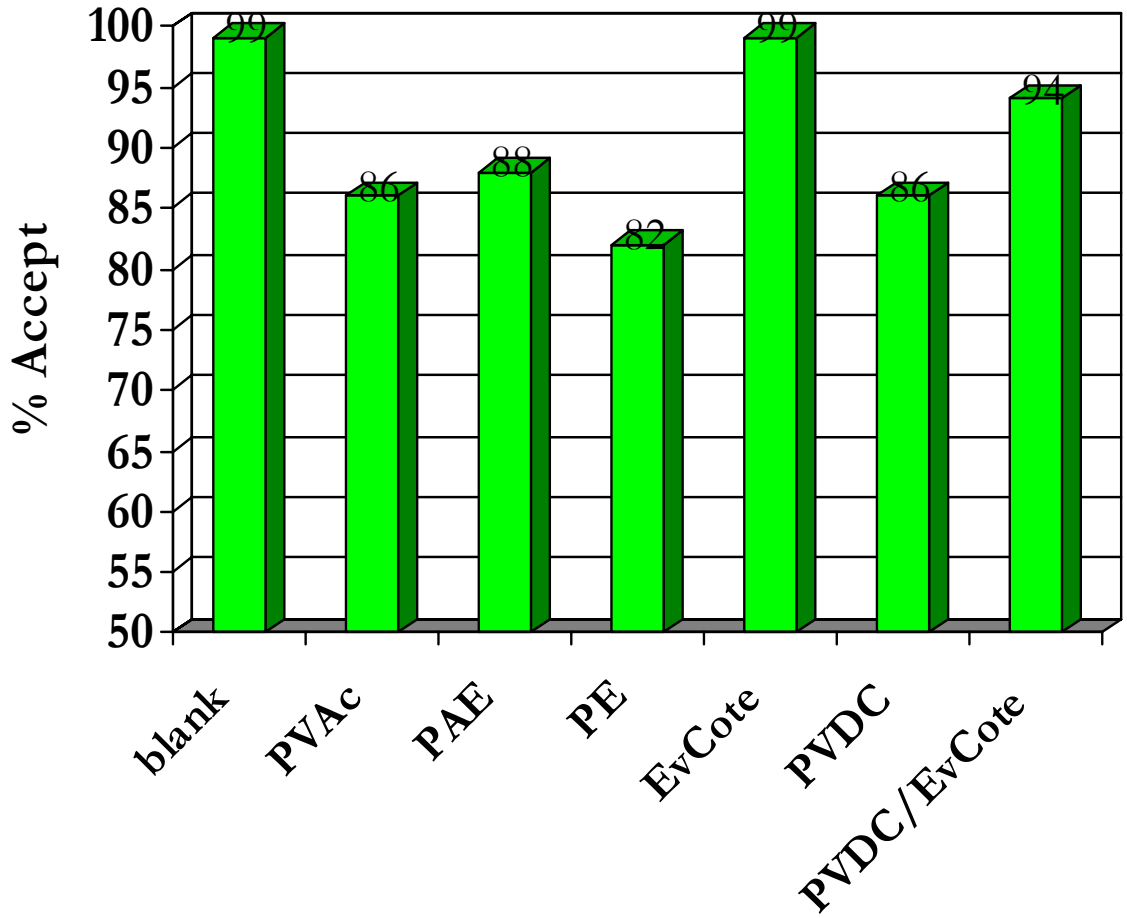
Testing and Evaluation
More Areas of Interest

- Glueability
  - Hot melt measured as % fiber pull; cold set as time to fiber tear
  - Hot melt glue
  - Cold (acetate) glue
  - Coated side to coated side
  - Coated side to back side
- Recyclability/repulpability
  - Protocols under development
  - Removal of visual residue

Repulped Sheet: PET-based Coating



Recyclability of Functional Barrier Coatings



Concerns and Considerations

- Barrier integrity at folds
  - Film flexibility
- Edge wicking resistance
- Foaming
  - Air entrainment/pinholes
- Control of holdout
- Blocking
- Cost

A Balancing Act

There are always exceptions, but …

- Greater heat sealability = more blocking
- Higher coating water retention = poorer water barrier effectiveness
- Higher water barrier = poorer cold glueability
- Higher oil resistance = poorer hot melt adhesion
- Higher effectiveness = higher cost

Summary

- Barrier properties open new markets to existing grades
- Main drivers: environmental and economic
- FC concerns: development of alternative chemistries
- Products now on the market show a high degree of application flexibility
- Wax and PE cost increases: oil related

For more information

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