Coatings Trends & Technologies SUMMIT

Controlled Free Radical Polymerization (CFRP) Dispersant Technology

Tony Moy
Sr. Technical Specialist
BASF Formulation Additives

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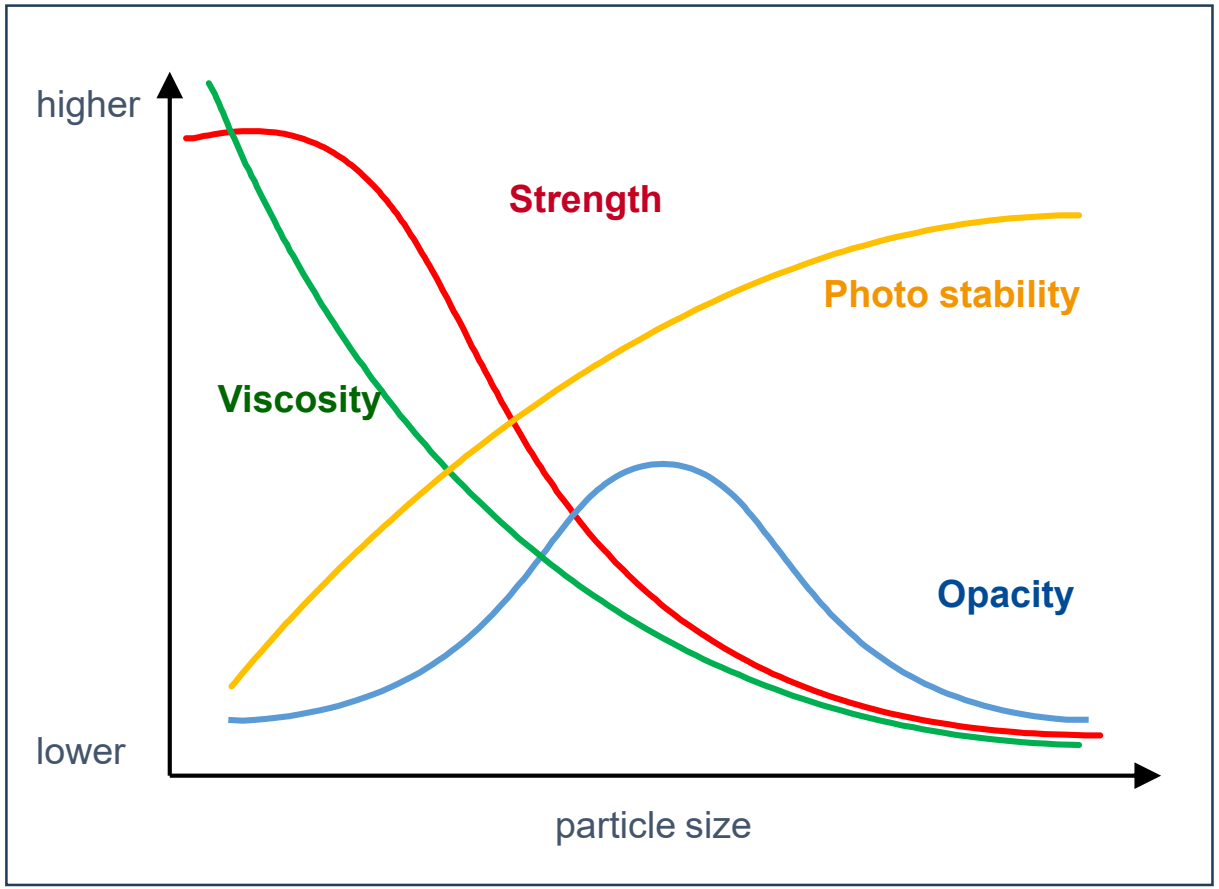
Agenda

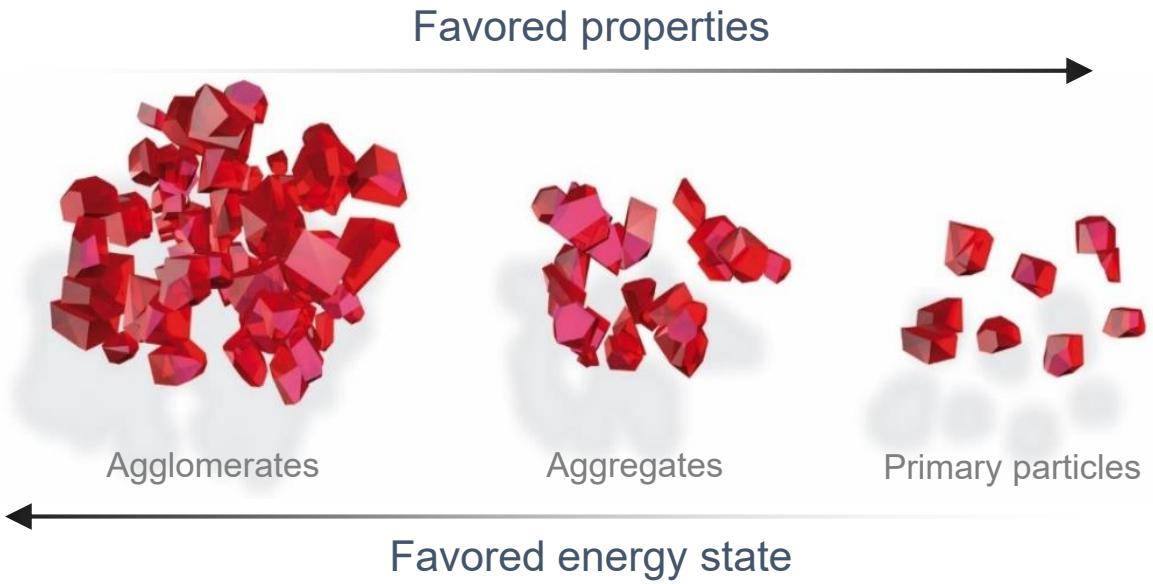
- Theory: Why Dispersing Agents – Mode of Action
- Chemistry: Controlled Free Radical Polymerization (CFRP)
- Application Example: Showing benefits of CFRP dispersant technology

Dispersing Agents
What and Why

- **Dispersants** are chemical substances:
  - Several forms: surface actives (surfactants) and polymers
  - Used to make dispersions of solids/particles (pigments)
    - Stabilize and disperse (keep apart) pigment particles
  - Have two functional aspects:
    - Pigment affinity
    - Compatibility with medium

Theory
Need for dispersion





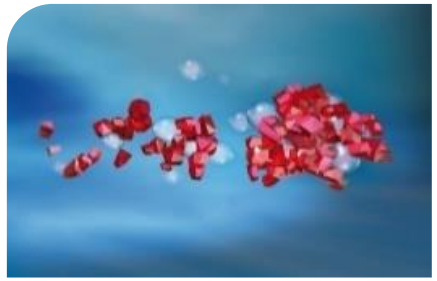
- Pigment delivery form: agglomerates
- Optimum coloristic properties at lower particle size
- More pigment surface leads to viscosity increase

Theory

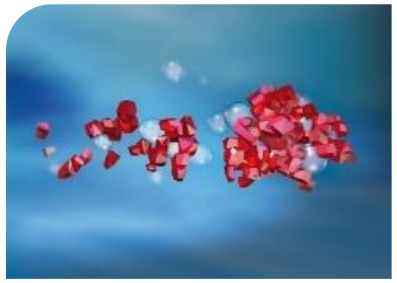
Three steps: Wetting → Breakdown → Stabilization

Wetting

Penetration
Air removal



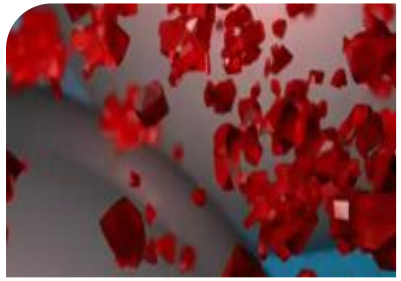
- Reduction of surface tension difference between solid and liquid phase to improve pigment wetting



Break down

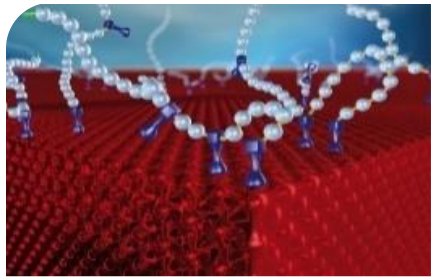
+ “Energy Input”

- Pigment particle size reduction leads to unfavorable energy state



Stabilizing

+ “Dispersant”

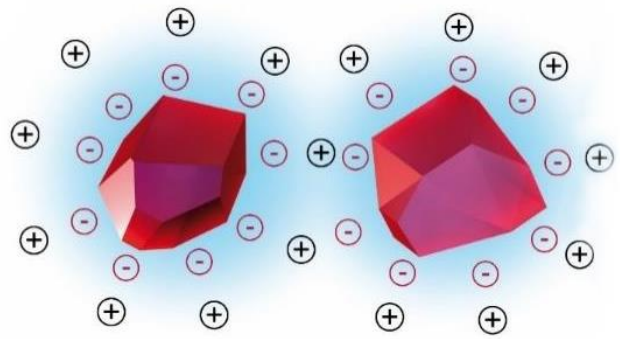


- Dispersant adsorbs on pigment surface to prevent re-agglomeration

Theory
Stabilization mechanisms

Charge Stabilization
Electrostatic Repulsion

→ Particles carry surface charge

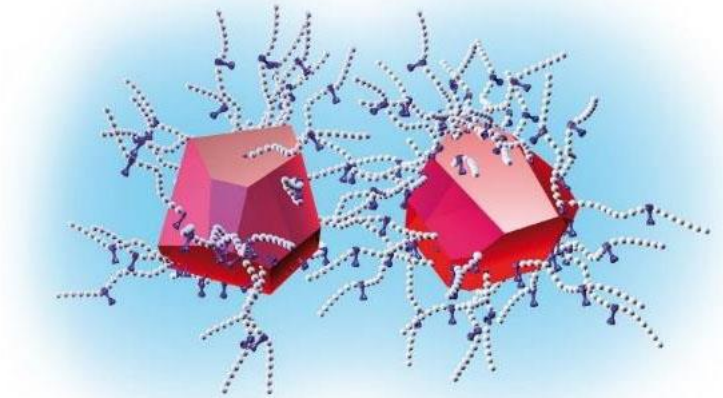


repulsive force

- Main relevance for dispersions in water and inorganic pigments
- Stability can be disrupted by high salt concentrations

Steric or Entropic Stabilization
Steric Hindrance

→ Solvent soluble polymer chains anchored to particles

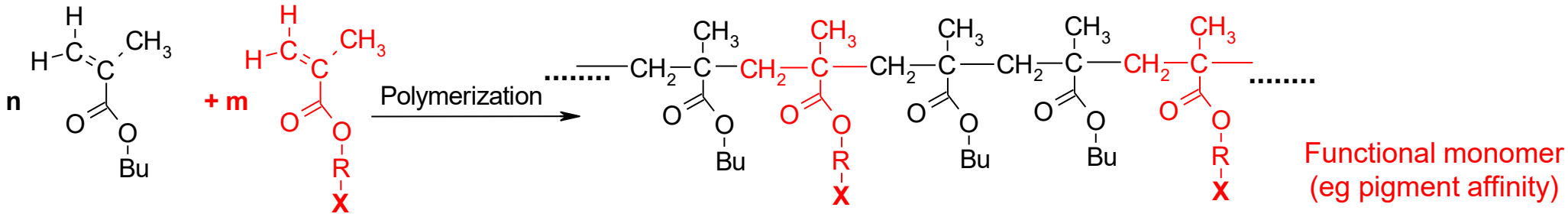


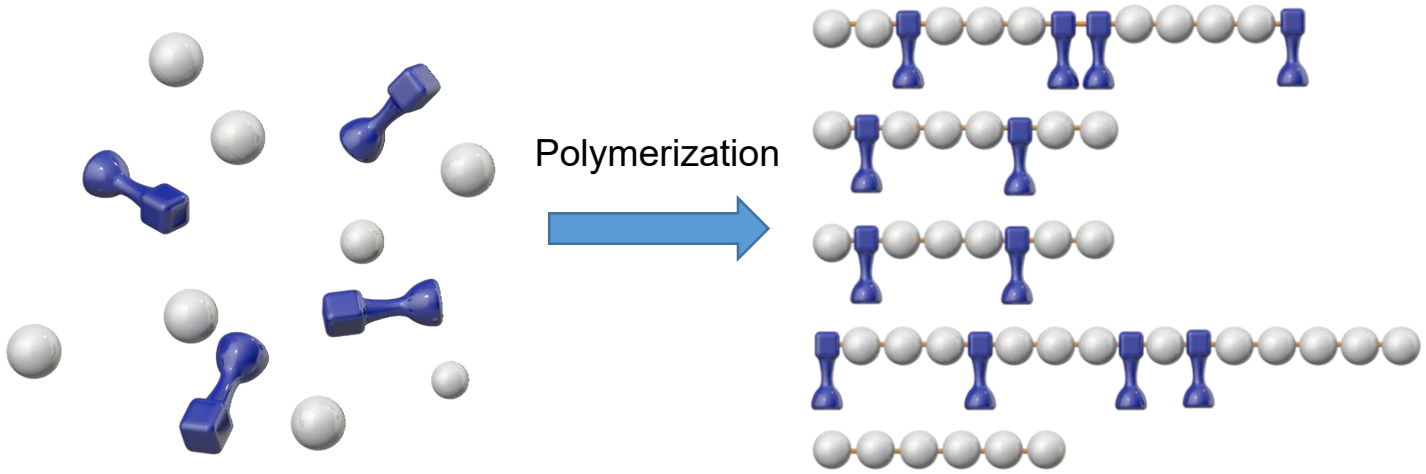
repulsive force (osmotic pressure)

- Effective in both solvent and water
- Most robust stabilizing mechanism

Chemistry

Limitations of conventional free radical polymerization





Limitations

- To achieve narrow weight distribution
- Defined chemical composition

Pigment specific monomer

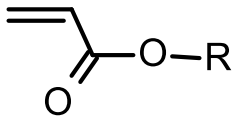
Resin & Solvent specific monomer

Chemistry
Block-copolymer dispersant design

Resin & Solvent specific **Pigment specific**

A-Block
Resin & Solvent specific
Stabilizer block

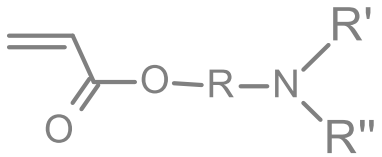
-> compatible to paint system:
resins & solvents



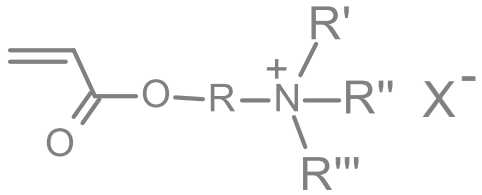
-> acrylates of different polarity and solubility

B-Block
Pigment specific
Pigment achoring block

-> e.g.
functional acrylates



-> and/or cationic/ionic groups



Advantages of block-copolymer design

- Defined polymer architecture: each block has distinct function
- Improved dispersant adsorption through high local concentration pigment affinity groups

Pigment specific monomer

Resin & Solvent specific monomer

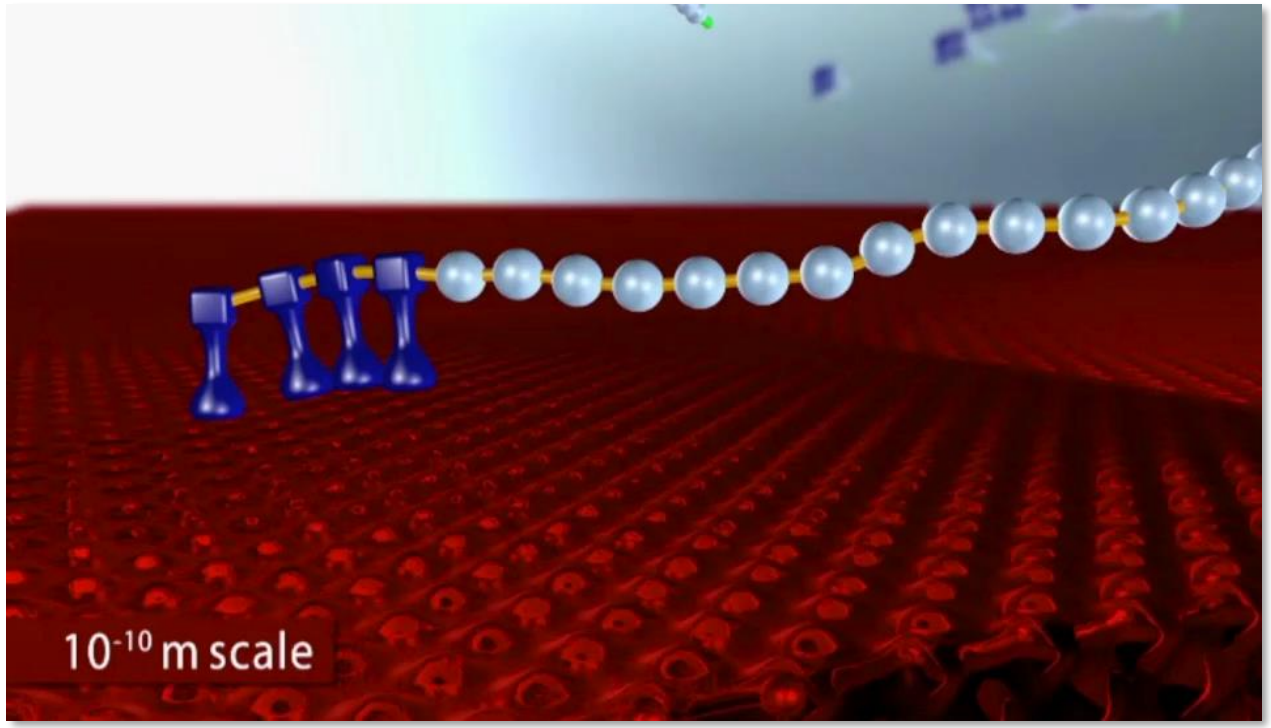
Chemistry
Benefits of CFRP technology

Well defined structures → higher efficiency

- Strong pigment affinity
- Excellent flocculation resistance

Well defined structure of polymeric backbone

- Low mill base viscosity and high pigment loading
- Tuneable compatibility

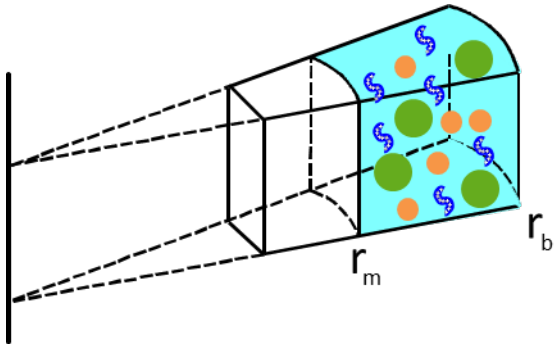


Chemistry
Improved Adsorption on Pigment Surface

Measuring Dispersant Adsorption - AUC

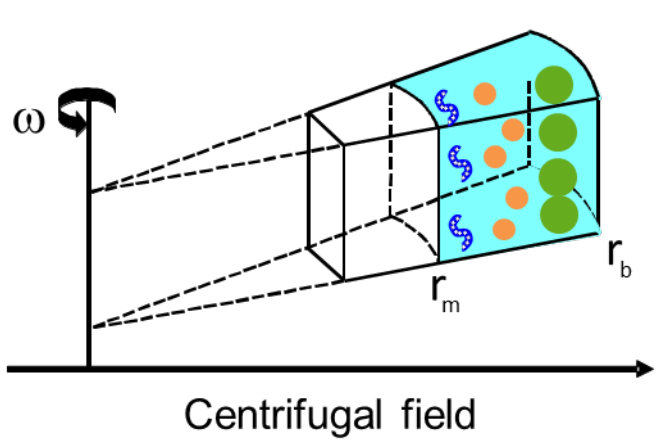
- **A**nalytical **u**ltra-**c**entrifuge: direct information of dispersant adsorption on pigment

1. Homogeneous distribution without centrifugal field



- Agglomerated pigment
- Dispersed pigment
- Non-adsorbed dispersant

2. High-resolution separation and in-situ detection with centrifugal field



Chemistry
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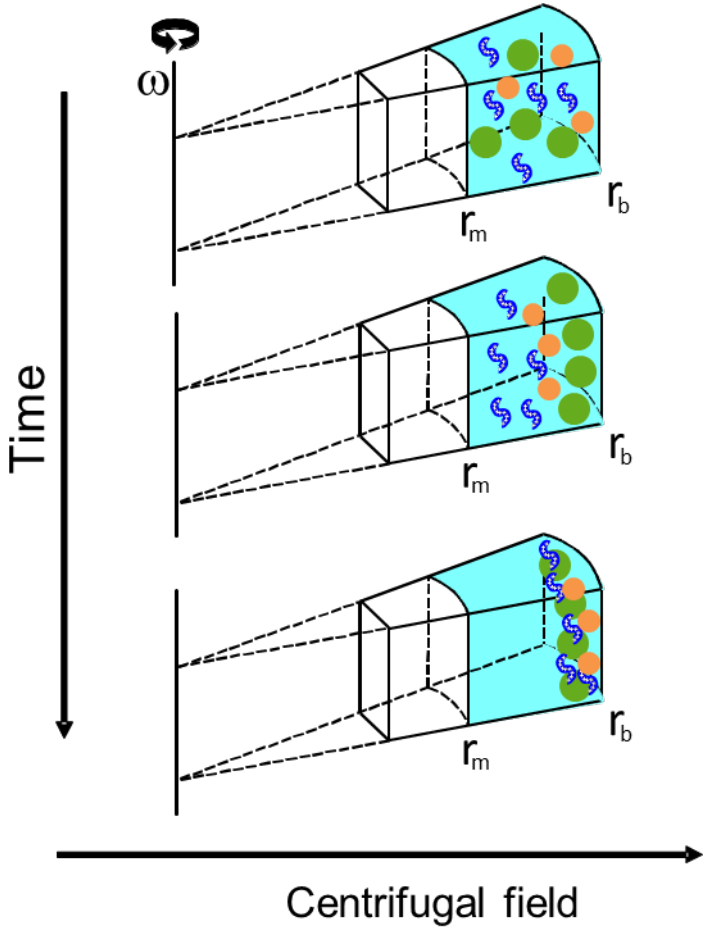
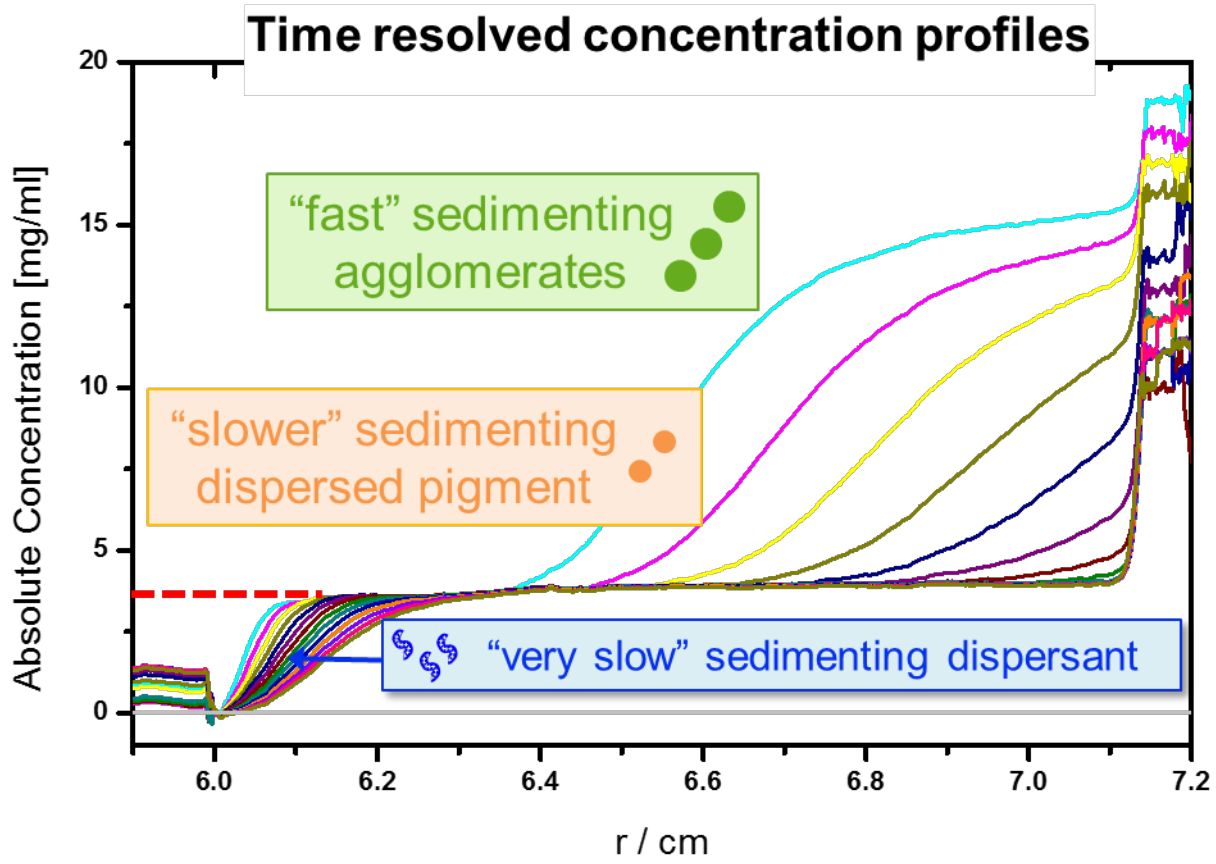
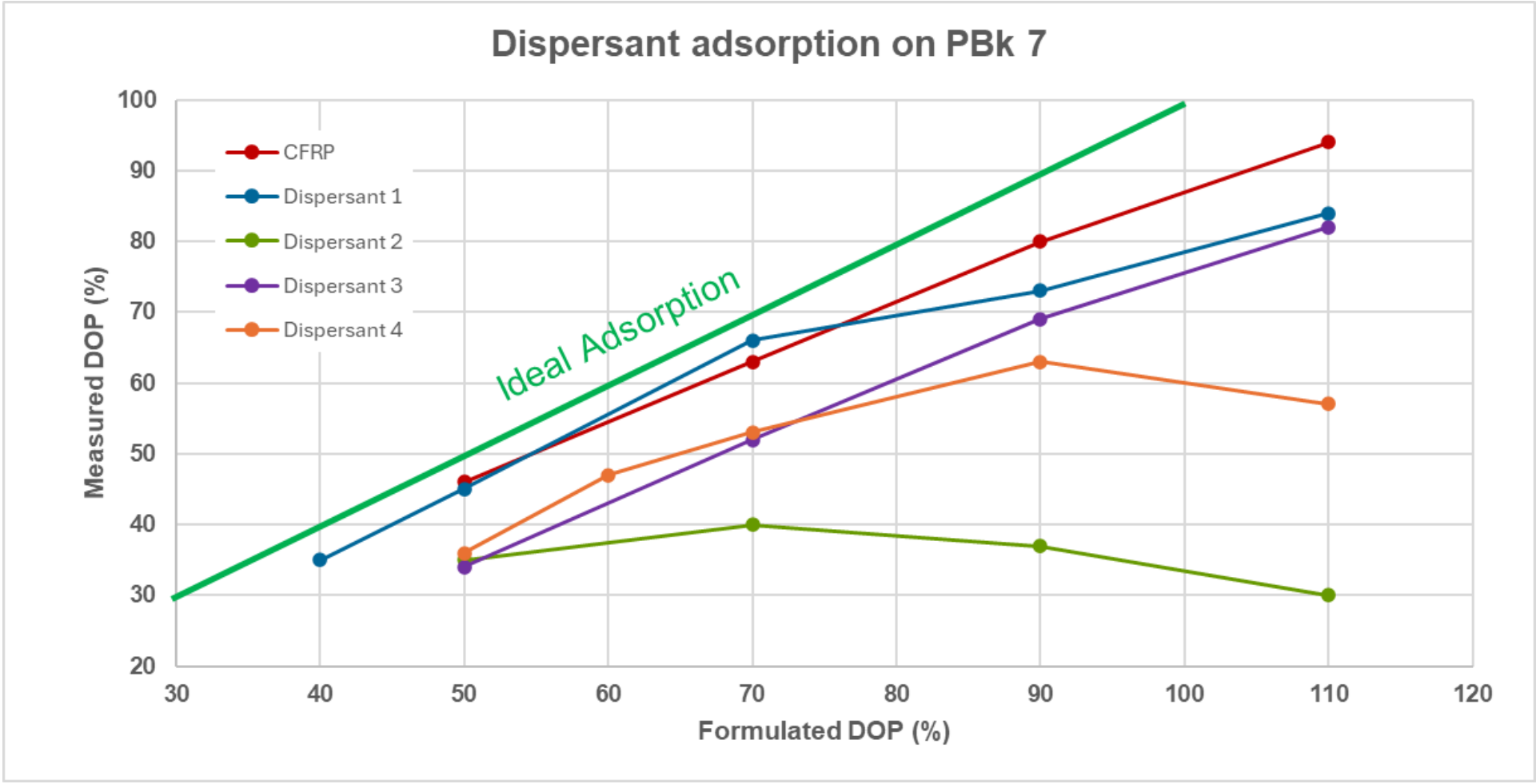
Measuring Dispersant Adsorption - AUC





Chemistry
Improved Adsorption on Pigment Surface



CFRP dispersant shows the closest to ideal adsorption behavior on pigment surface

Application Example

New CFRP Dispersant for Organic Pigments (including Carbon Black)

Technical benchmarking concept

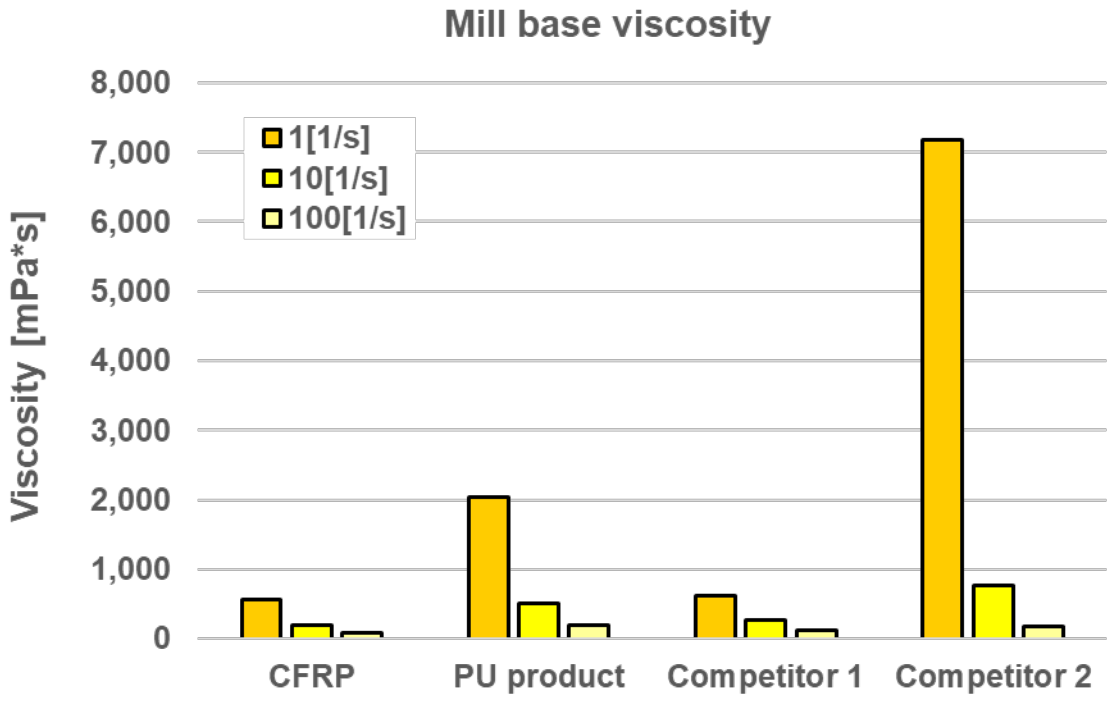
Mapping efficiency, effectiveness and opportunity for simplification

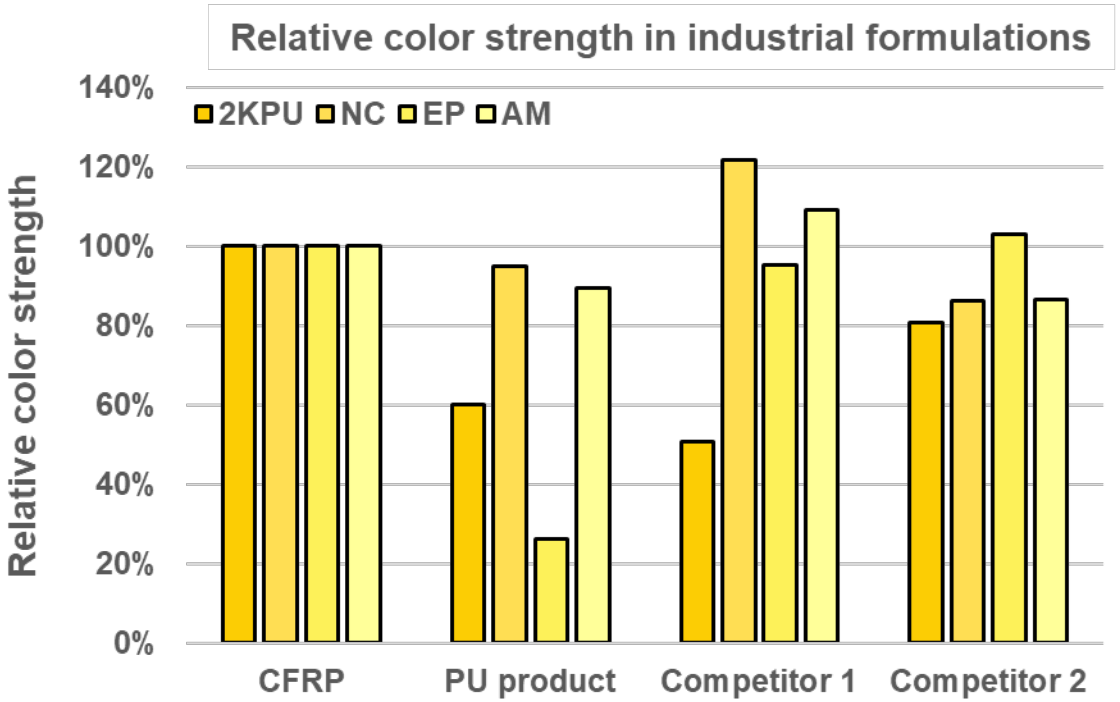
Technology	Resin system	Pigments	Dispersing agent
RFPC	2K	PY 139	CFRP
	1K	PR 122	PU
	NC	PR 179	Competition 1
RCPC	Epoxy	PBk 7	Competition 2
	Universality in solvent based industrial systems	Across different particle size range & chemistry	

Efficiency & simplification		Effectiveness		
Viscosity	**Compatibility**	**Color strength**	**Jetness**	**Transparency**

Application example

Opaque Reddish Isoindoline Yellow Organic Pigment (PY 139)



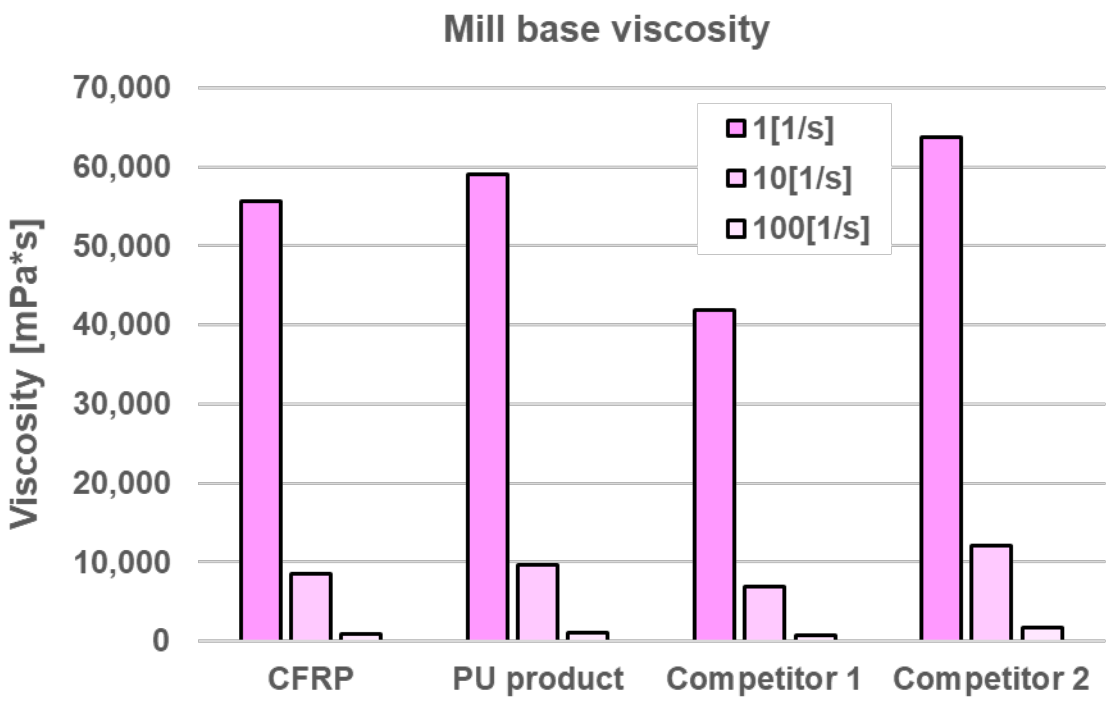


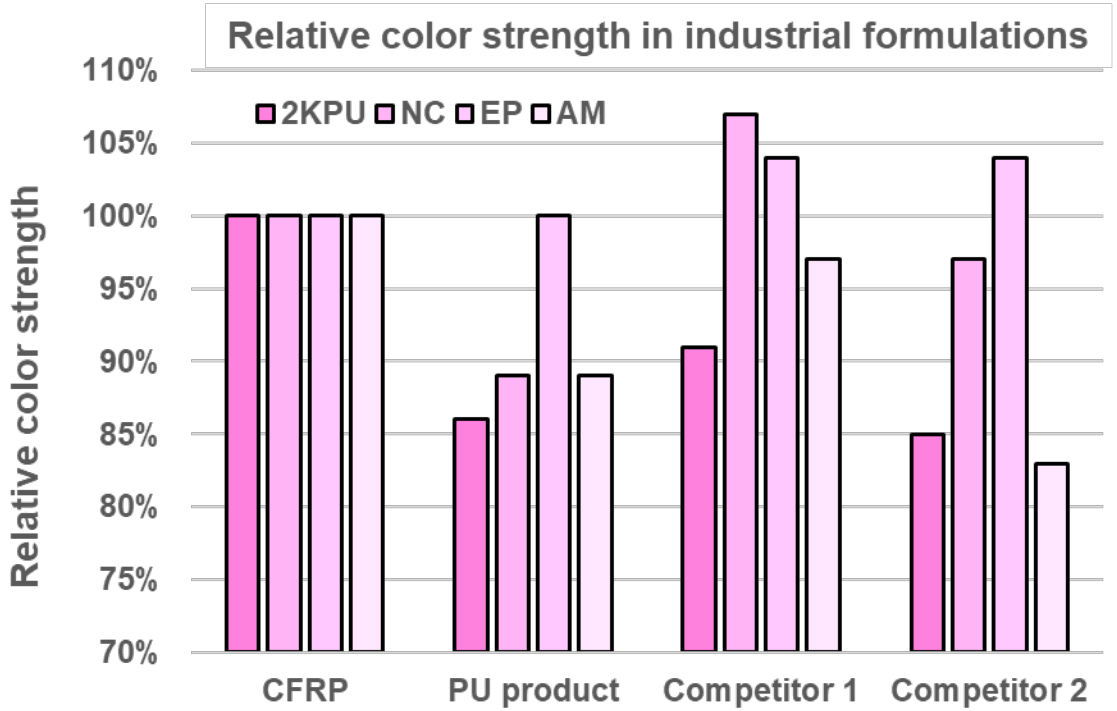
Formulation		
	Mill base:	Resin-free
	Pigment loading [%]:	45
	Dispersant dosage (SDOP) [%]:	20

CFRP dispersant provides good viscosity control and excellent compatibility in a broad range of resin systems

Application example

Quinacridone Neutral Shade Magenta Pigment (PR 122)



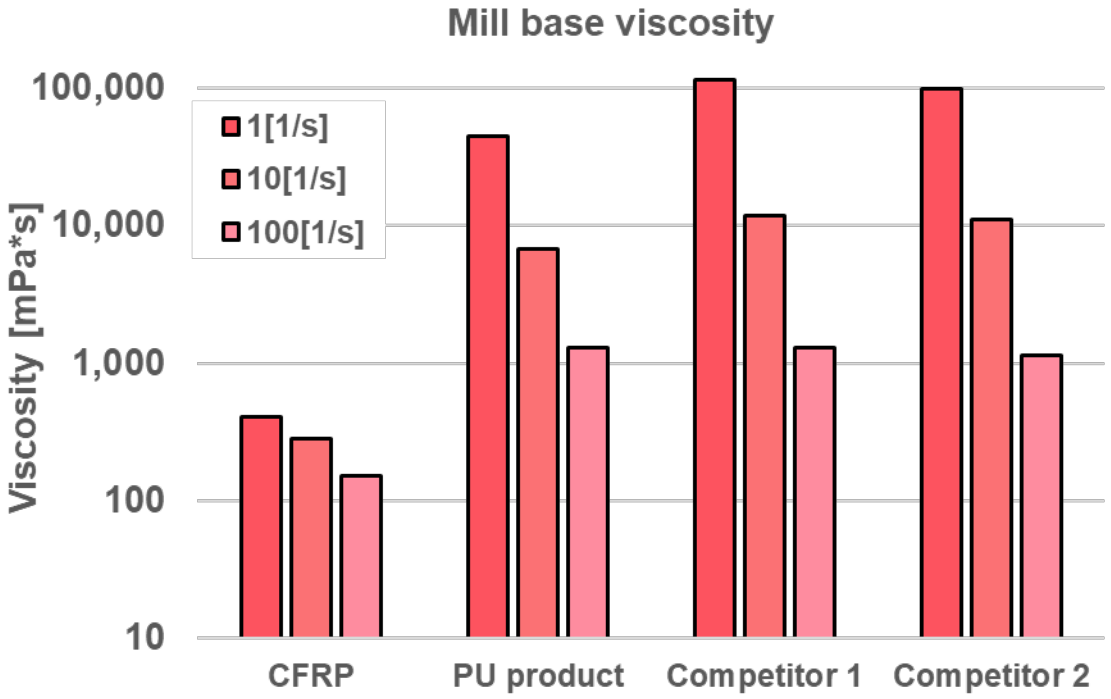


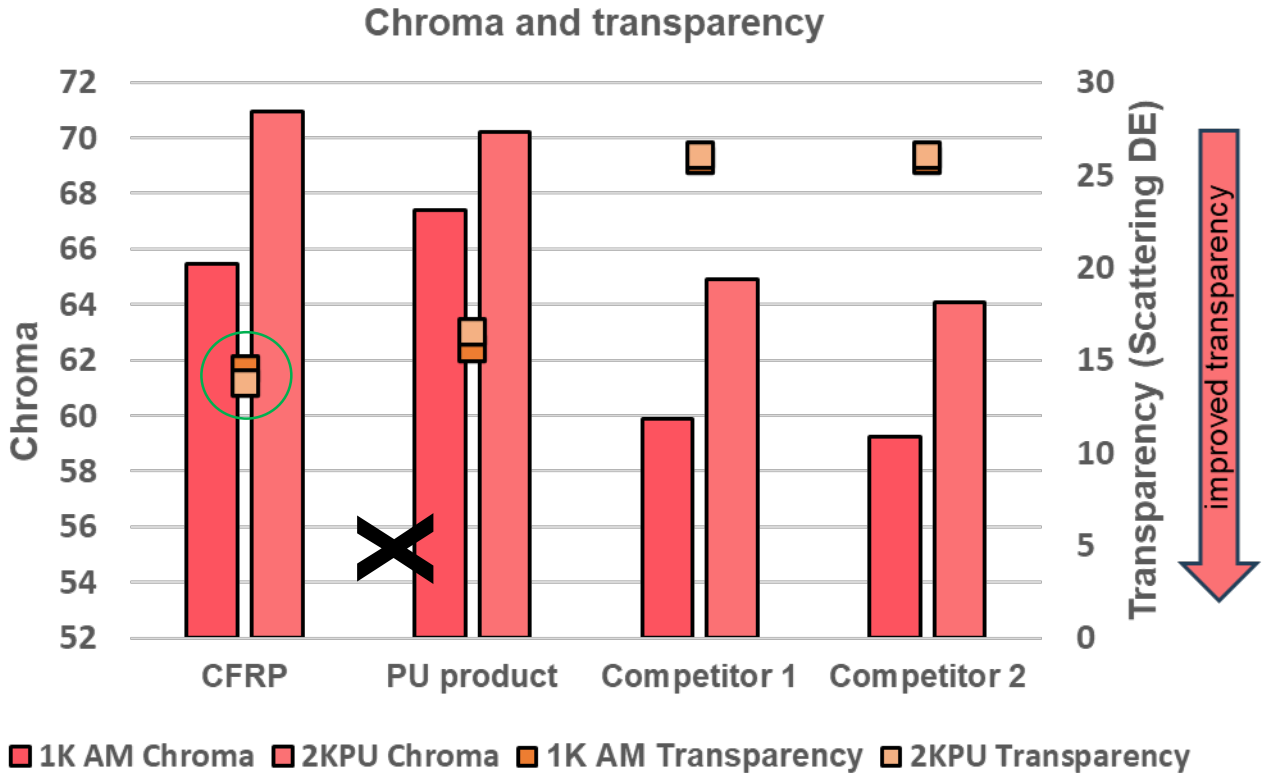
Formulation		
	Mill base:	Resin-free
	Pigment loading [%]:	17.5
	Dispersant dosage (SDOP) [%]:	30

CFRP dispersant provides comparable viscosity control and excellent compatibility in a broad range of resin systems

Application example

Paliogen Red L 3885 (PR 179)



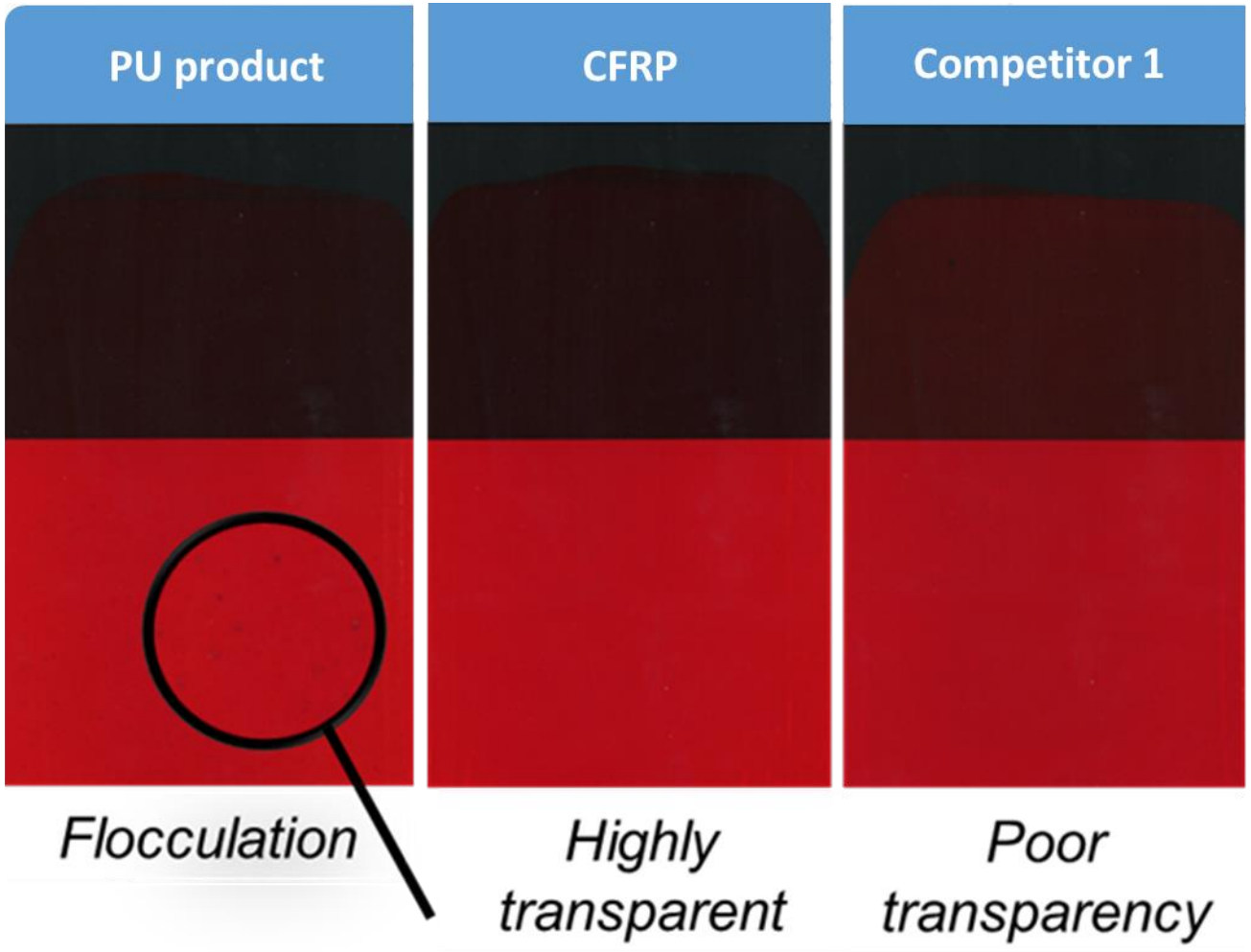


Formulation		
	Mill base:	Resin-free
	Pigment loading [%]:	24
	Dispersant dosage (SDOP) [%]:	40

CFRP dispersant provides best viscosity suppression and excellent coloristic properties

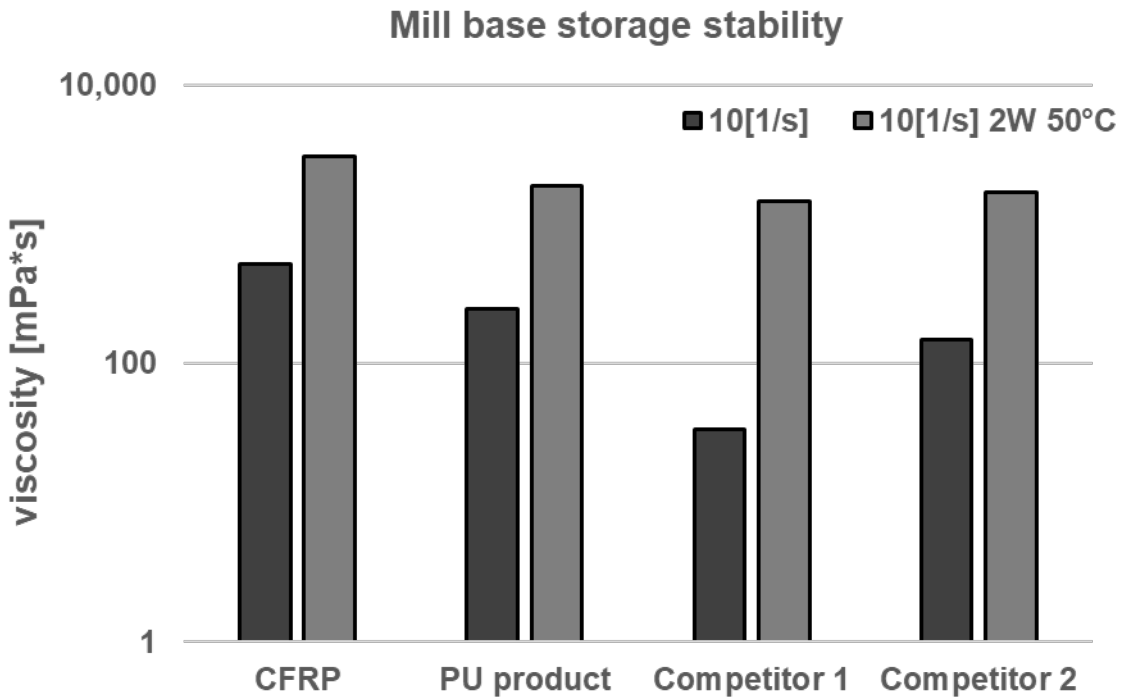
Application example

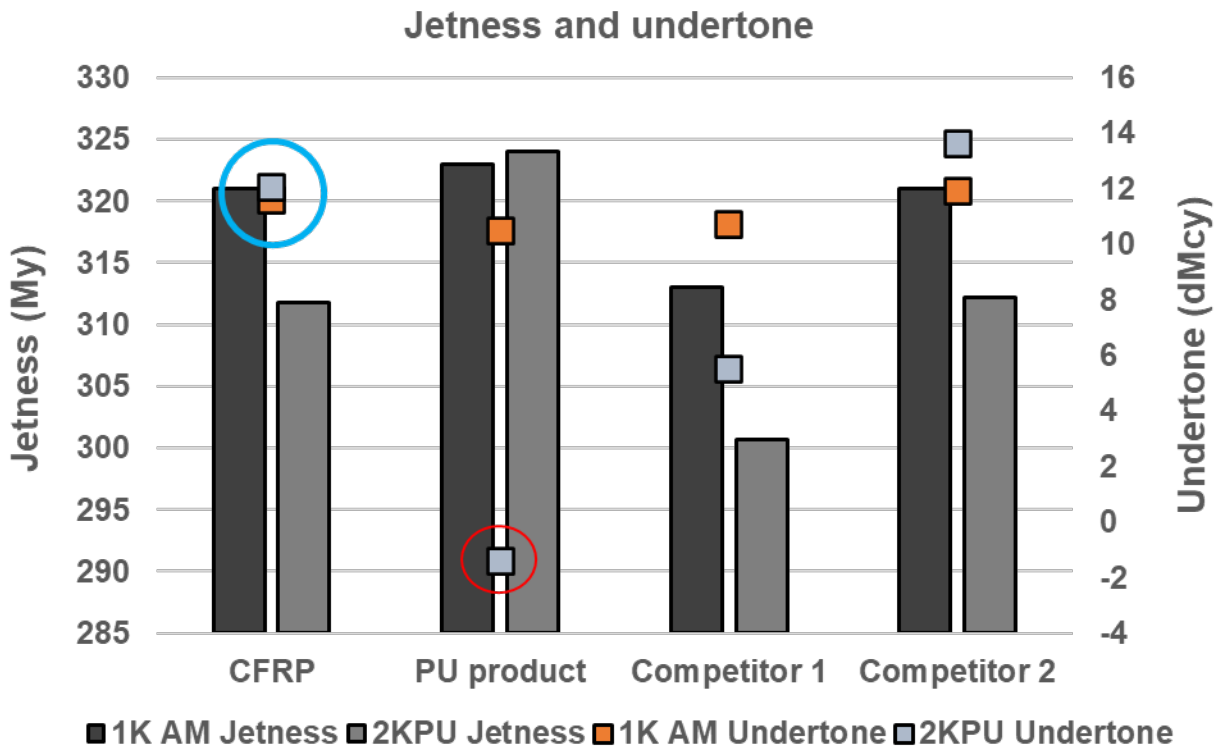
Transparent Perylene Red Pigment (PR 179)



CFRP dispersant provides highest transparency

Application example
Specialty Carbon Black (PBk 7)





Formulation		
	Mill base:	Resin-free
	Pigment loading [%]:	14
	Dispersant dosage (SDOP) [%]:	90

CFRP dispersant provides constant high bluish undertone in different application systems


Questions?

Contact Information

Tony Moy

Sr. Technical Specialist

anthony.moy@basf.com

Website: basf.us/dpsolutions

E-Mail: formulation-additives-nafta@basf.com