introduction to thickeners and rheology modifiers

Speaker Tour – GGSCT&PNWSCT 2019

Natalia Lopes
coatings technical service

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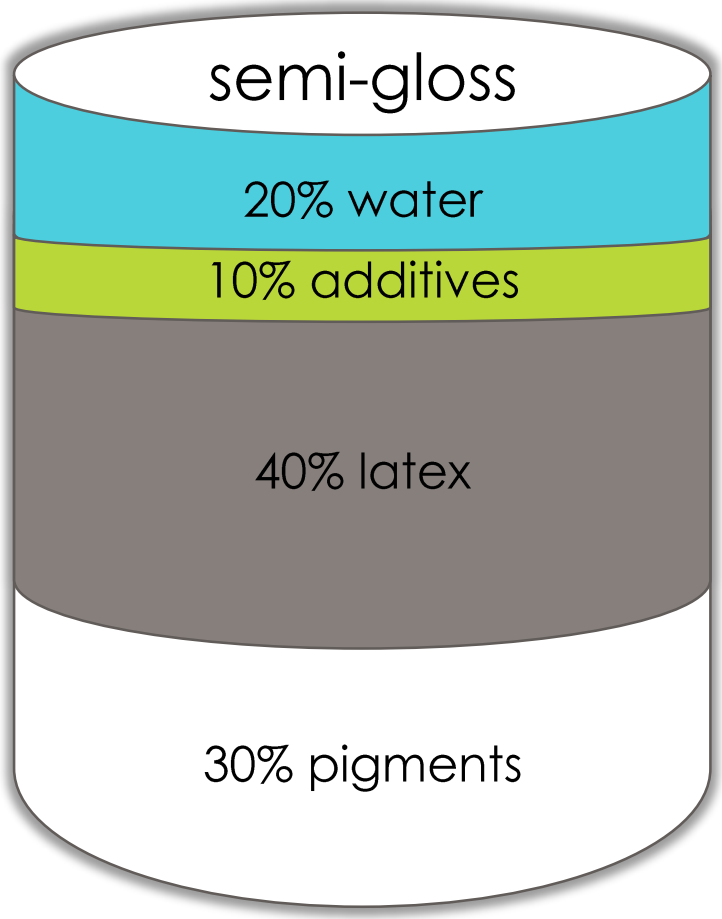
why do we need them?

rheology modifiers dictate a paint's application feel and influence final dry film appearance.

- choosing the right rheology modifier results in:
  - smooth finish
  - exceptional sag/level balance
  - high paint stability
  - low VOC
  - excellent wet and dry hiding
  - control and minimization of formulation costs



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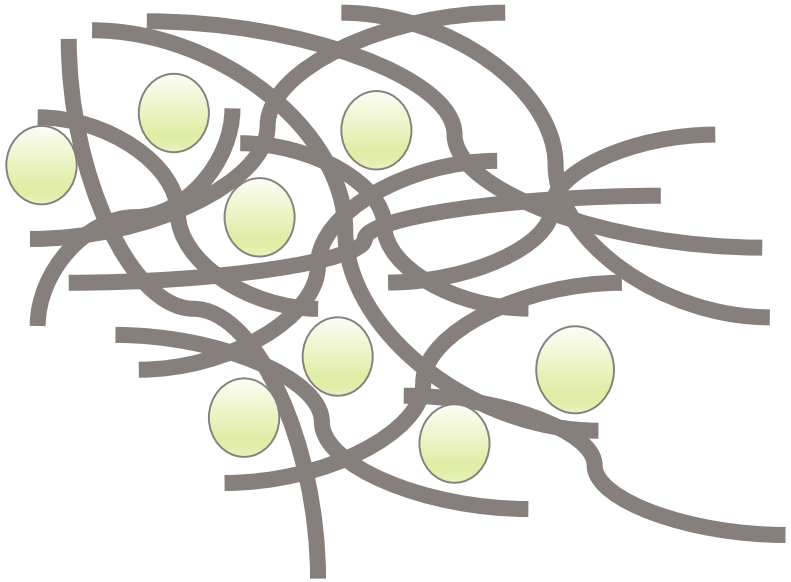
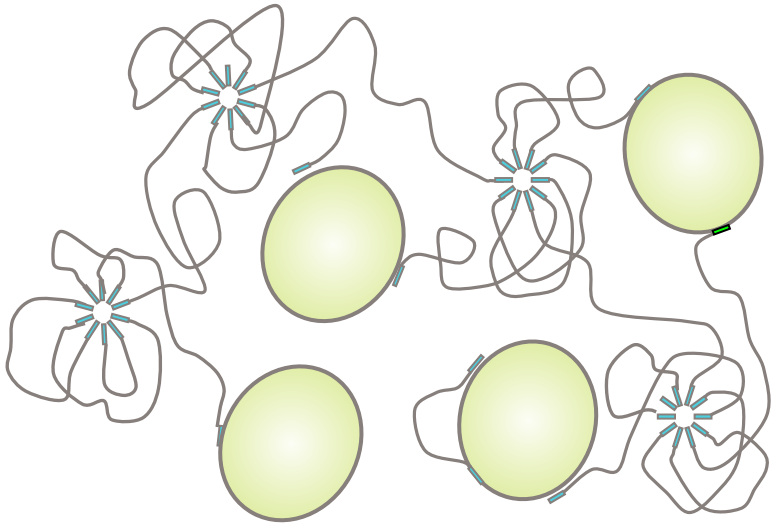
thickening mechanisms



Conventional
(Volume)



Associative
(Association)

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types of rheology modifiers

	SYNTHETIC	NATURAL DERIVATIVES
CONVENTIONAL	Polyvinyl alcohol Polyacrylamide Polyacrylic acids ASE - **A**lkali **S**oluble **E**mulsion	Cellulose ethers: CMC - **C**arboxy**M**ethyl**C**ellulose HEC - **H**ydroxy**E**thyl**C**ellulose MHEC - **M**ethyl**H**ydroxy**E**thyl**C**ellulose
ASSOCIATIVE	HM-PAPE - **H**ydrophobically **M**odified **P**oly**A**cetal **P**oly**E**ther HEUR - **H**ydrophobically Modified **E**thoxylate **UR**ethane HASE - **H**ydrophobically Modified **A**lkali-**S**oluble **E**mulsion	HMHEC - **H**ydrophobically **M**odified **H**ydroxy**E**thyl**C**ellulose

Others: clays, bentonite...

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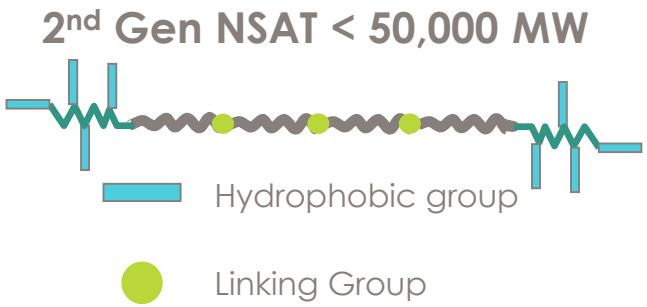
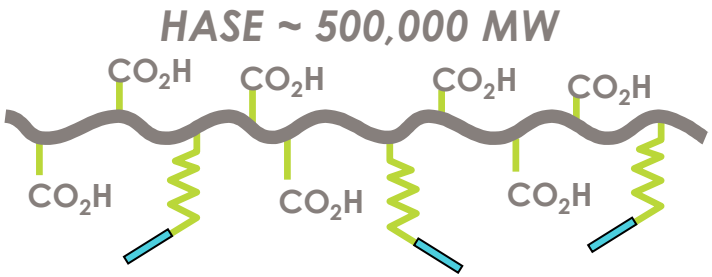
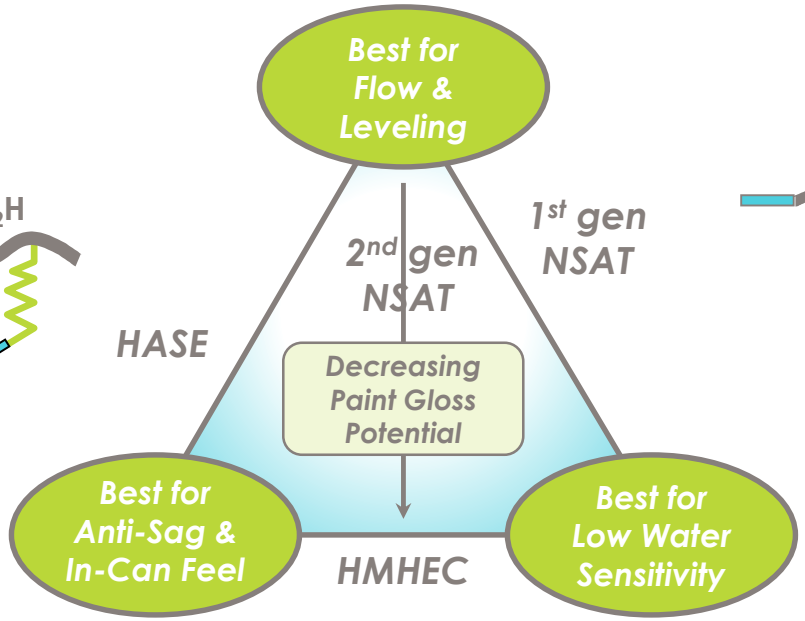
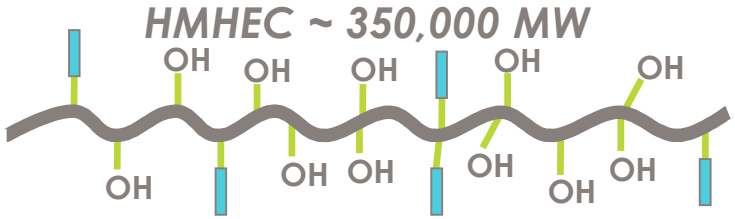
associative thickener structures









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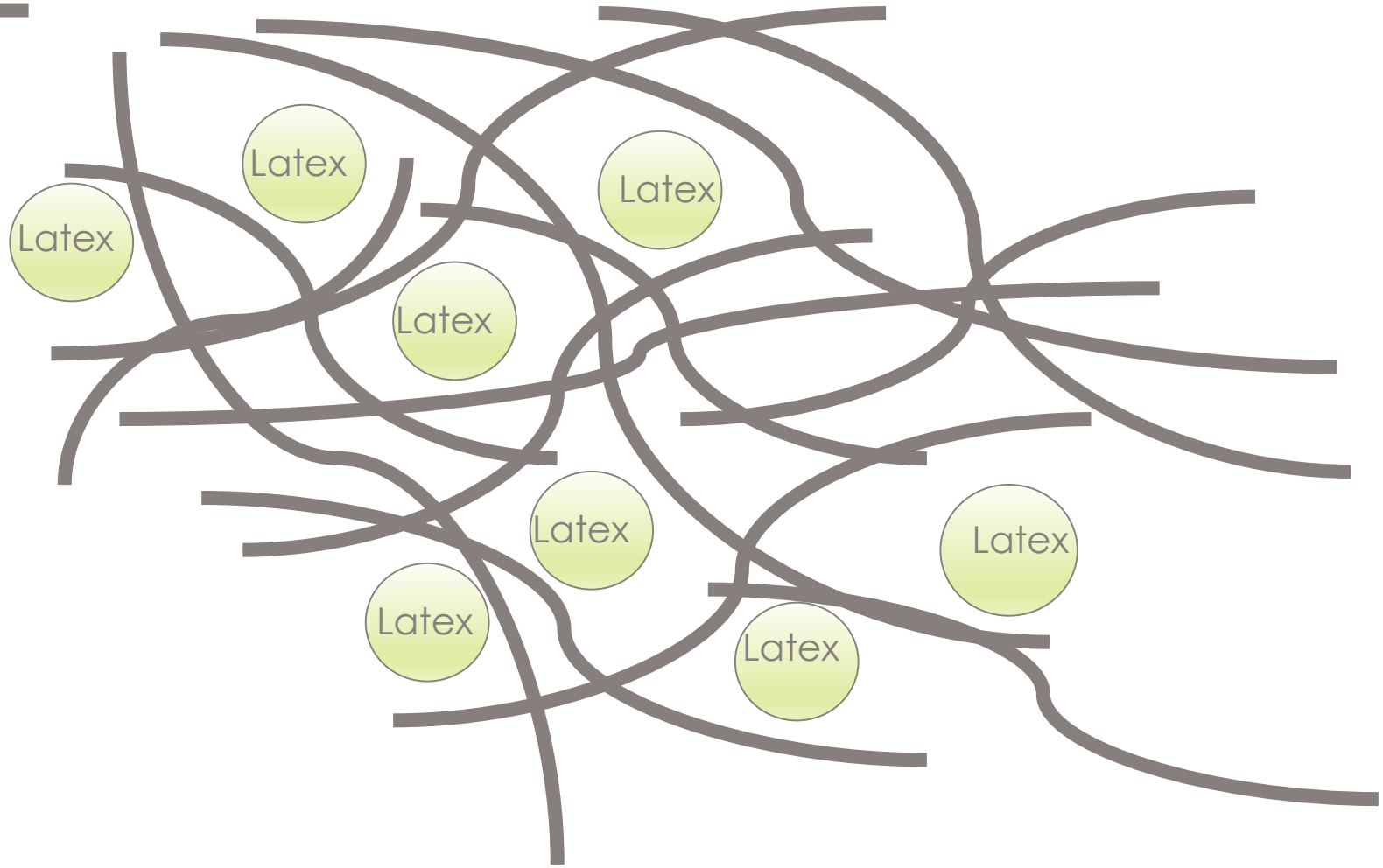
HEC thickening mechanism



molecular weight → major factor for thickening

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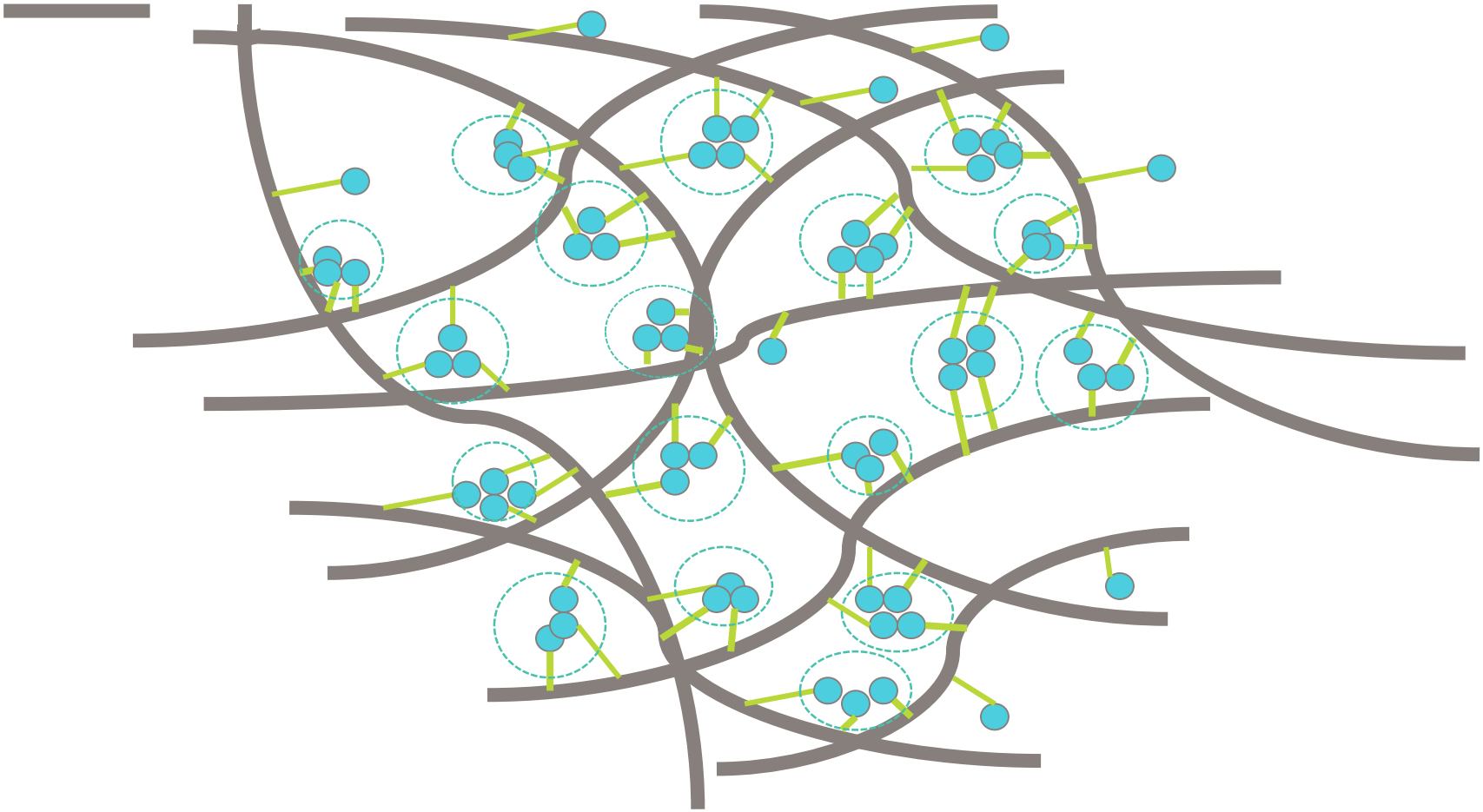
HEC grade selection

Viscosity Grade/Molecular Weight Effects

60-PVC Vinyl-Acrylic Flat Paint, 95 KU

Thickener	Mw x10^3	lbs/ 100 gal	ICI, Poise	Spatter Resistance	Leveling	Sag, mils
High Mw	1,000	3.6	0.9	3	5	14
Med Mw	700	4.7	1.2	4	4	18
Low Mw	300	9.6	1.7	6	3	24+

HM-HEC thickening mechanism (in solution)



entanglement and hydrophobic association

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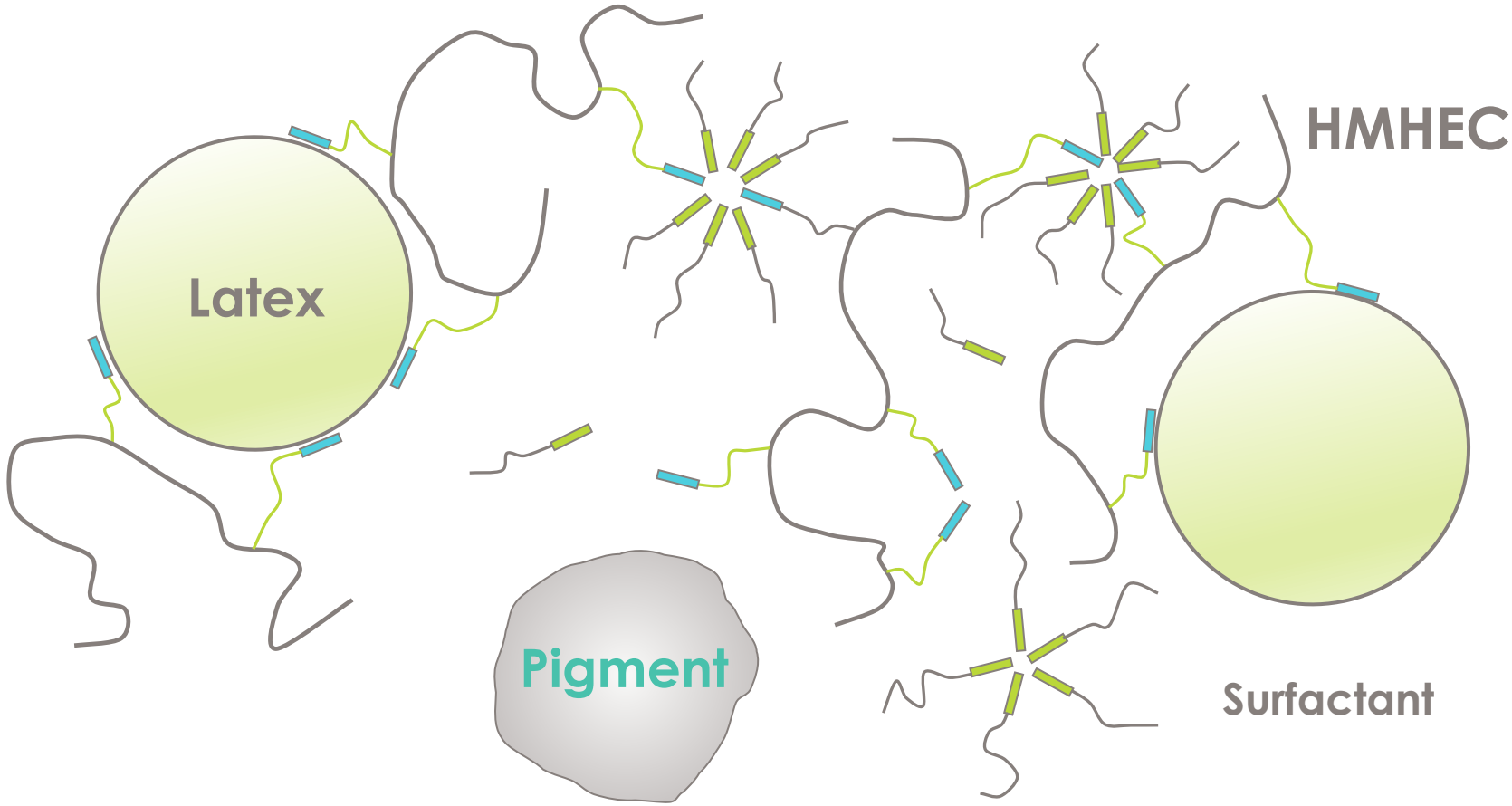
HM-HEC thickening mechanism (in paint)



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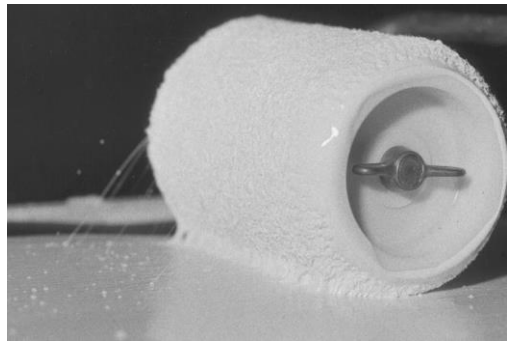
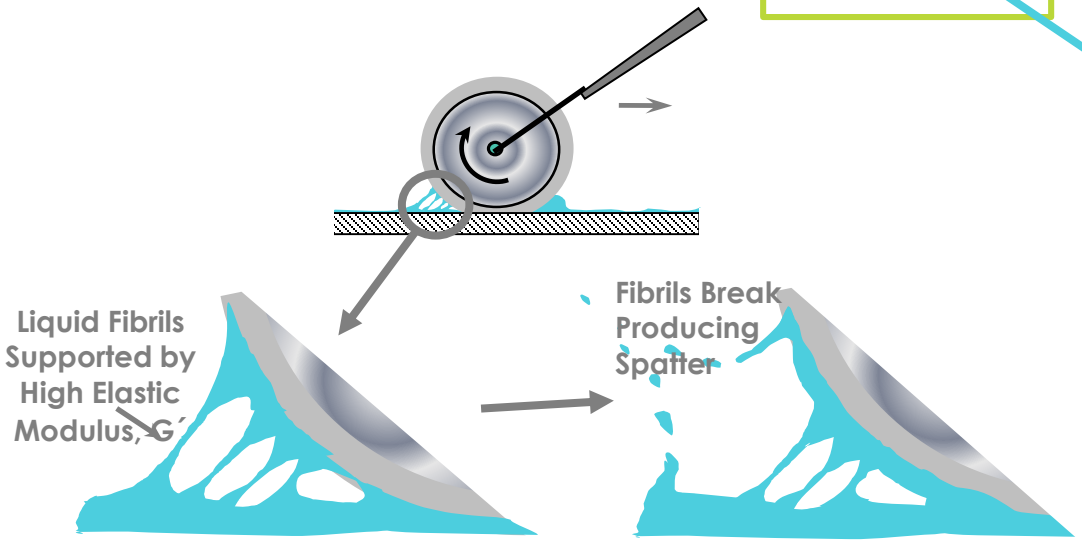
HEC vs. HM-HEC

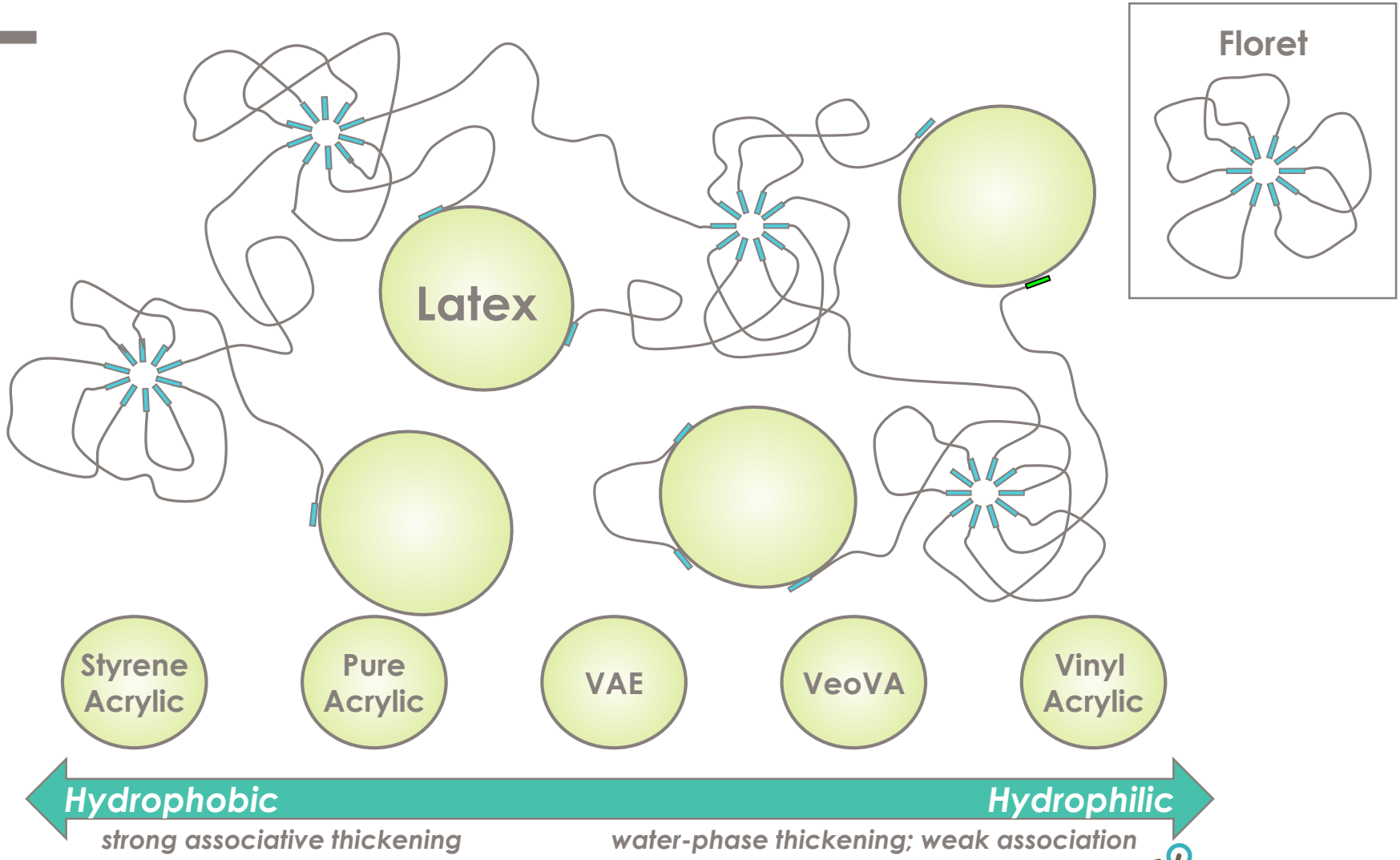
70-PVC Vinyl-Acrylic Flat Paint

Thickener	Thickening Efficiency Wt (%)	Thickening Efficiency lbs/ 100 gal	ICI, Poise	Spatter Resistance	Leveling	Sag, mils	Scrub Cycles
HEC	0.48	5.4	0.6	2	3	24	213
HM-HEC	0.63	7.2	0.9	9	3	18	223





NSAT associative thickening mechanism



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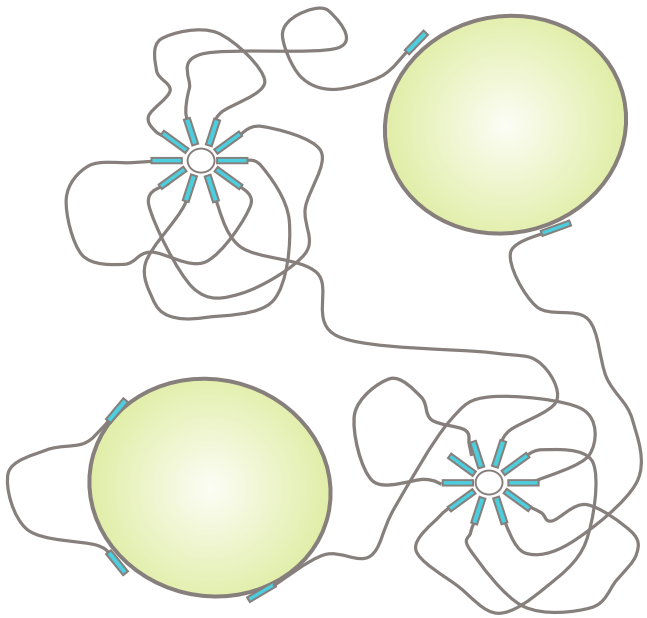
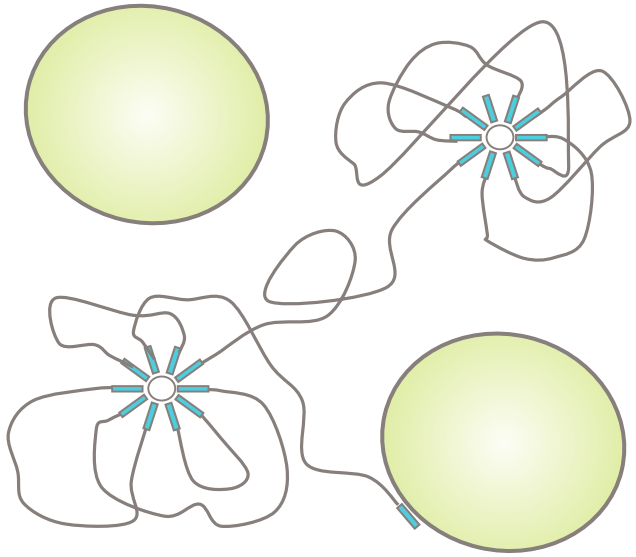
latex type effects

Acrylic Latex



Strong Interactions with NSAT
Contribute to Better Network

Vinyl-Acrylic Latex



Moderate Interaction with NSAT
Primarily Aqueous Phase Thickening

Hydrophobic ⟷ ***Hydrophilic***

strong associative thickening

water-phase thickening; weak association

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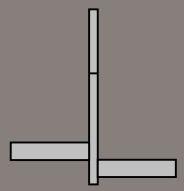
standard terminology

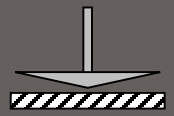
- two basic functional types of NSATs

Low-Shear Effective



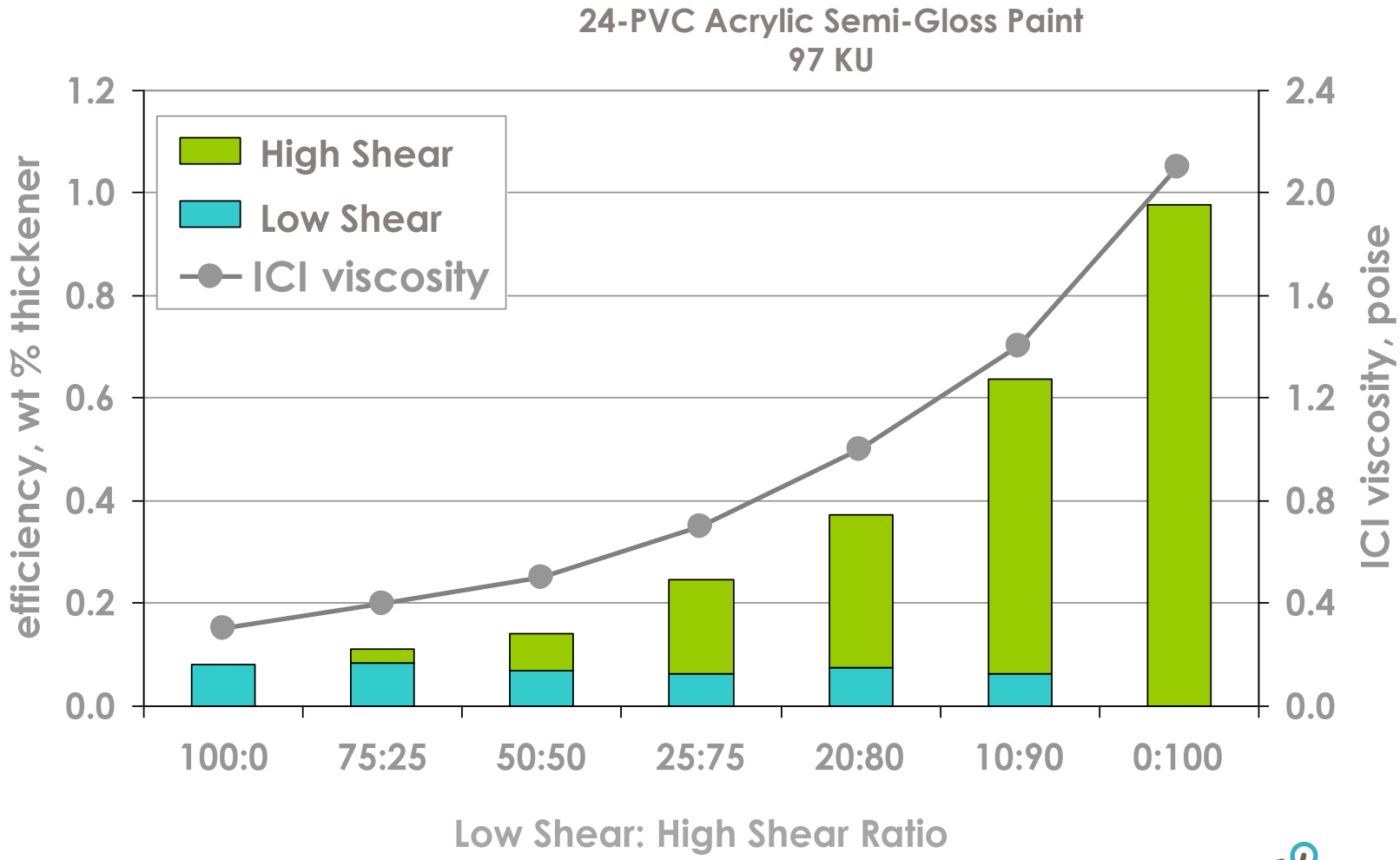
- **Stormer KU/Thickening**
- **More Efficient**
- **More Shear Thinning/Less Newtonian**

High-Shear Effective



- **ICI Viscosity**
- **Less Efficient**
- **Less Shear Thinning/More Newtonian**

formulating with Aquaflow™ rheology modifiers



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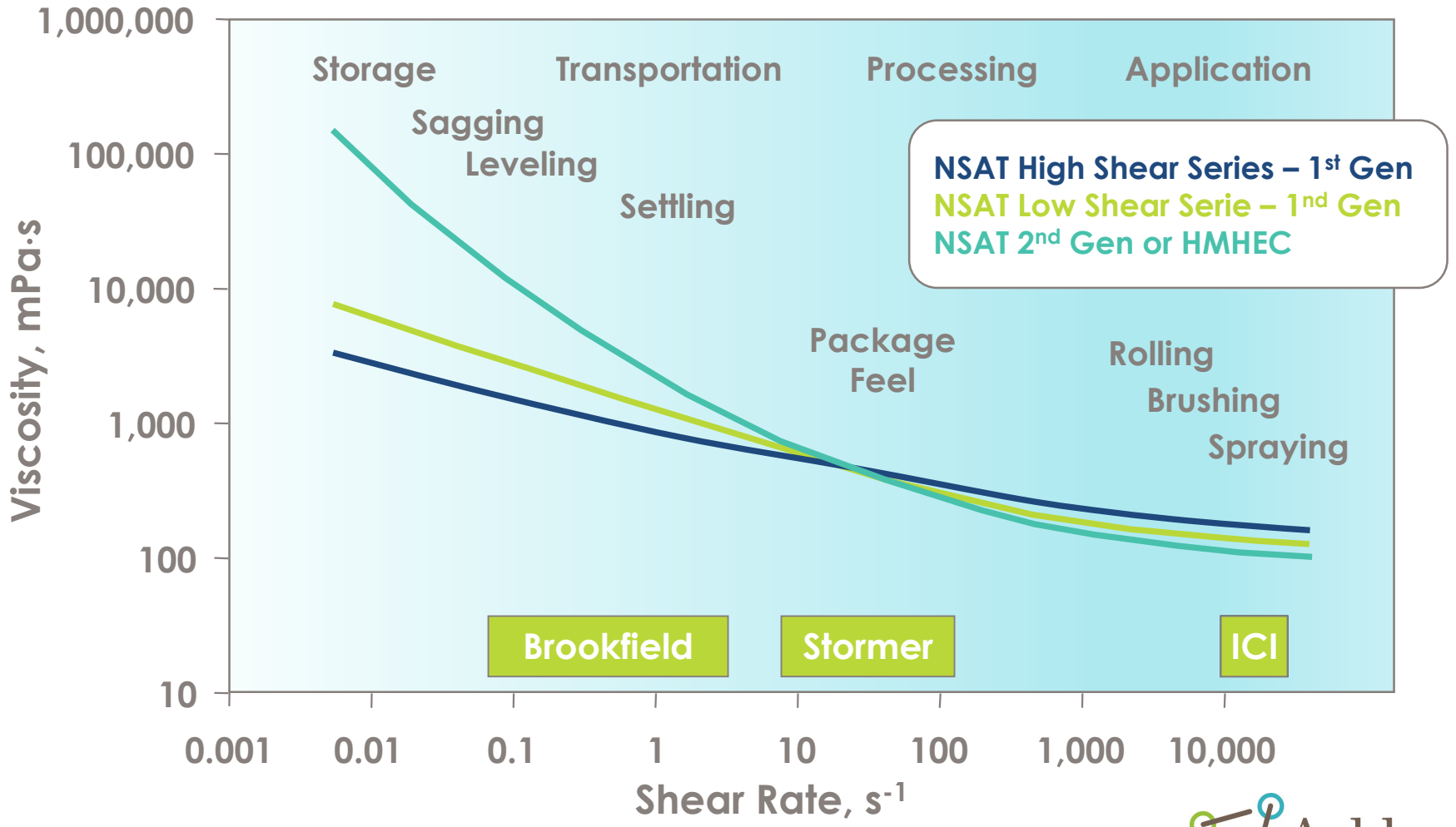
shear rate considerations



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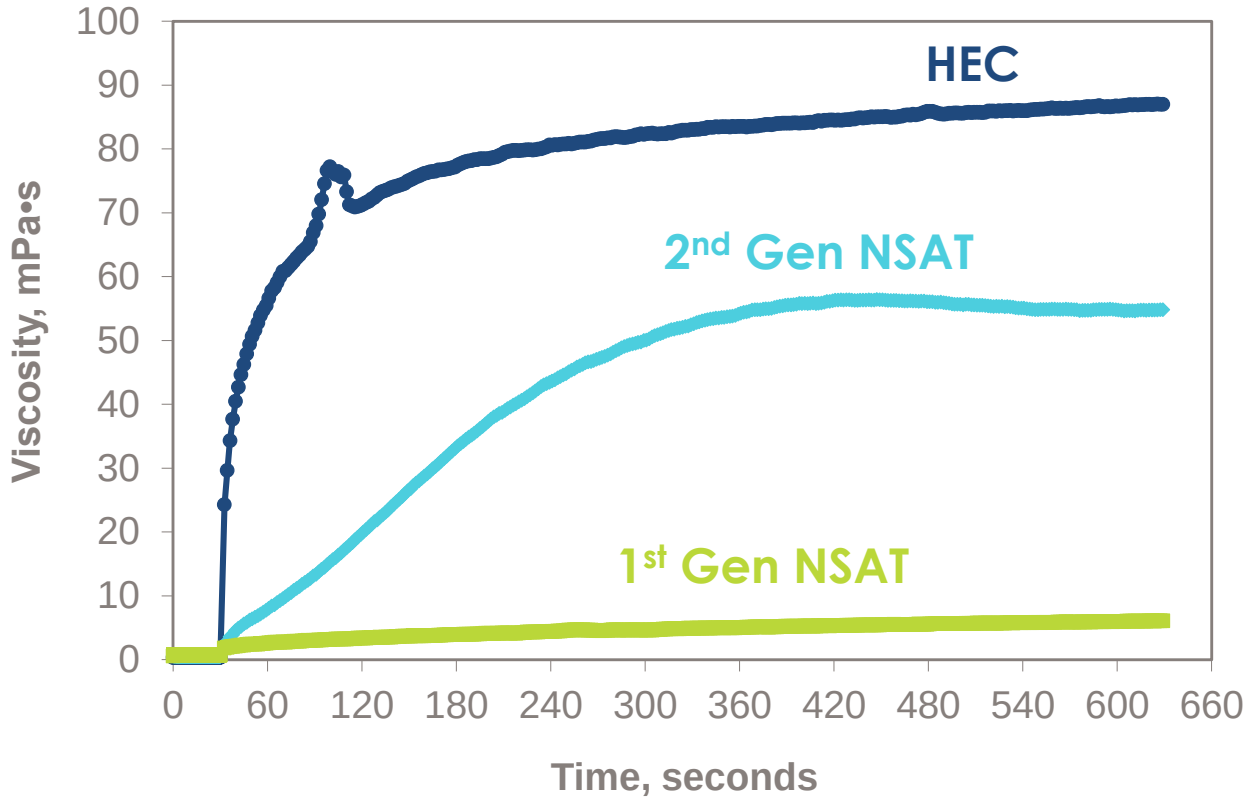
viscosity recovery profiles



2nd Gen NSAT viscosity recovery profile allows leveling to proceed while preventing dripping

Sag and Leveling balance

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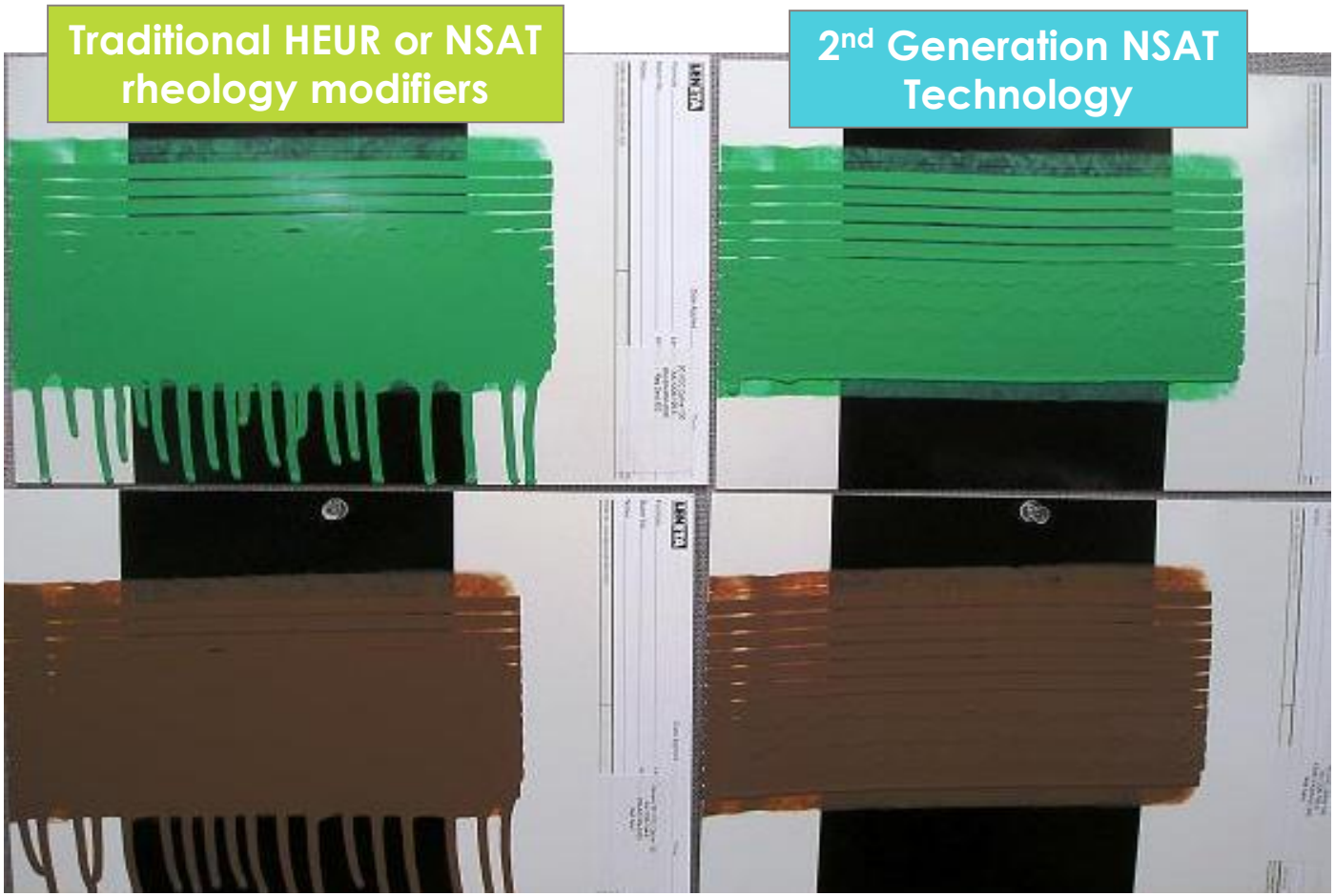
sag resistance and leveling balance

<50 g/L VOC Acrylic Semi-Gloss Deep Base



This no-drip behavior with excellent leveling is typical of Next Generation technology.

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experimental method

- 29 PVC, 29 VS VAE semi-gloss paint
  - HEC
  - NSATs: traditional HEUR, 1st & 2nd gen. PAPE
- drywall primed using flat black primer
- paints applied with 3/8" nap roller cover
- analyzed panels
  - visual ranking
  - pixel analysis
  - surface profilometry

visual panel rating

- subjective visual rating of the applied hide of painted drywall panels

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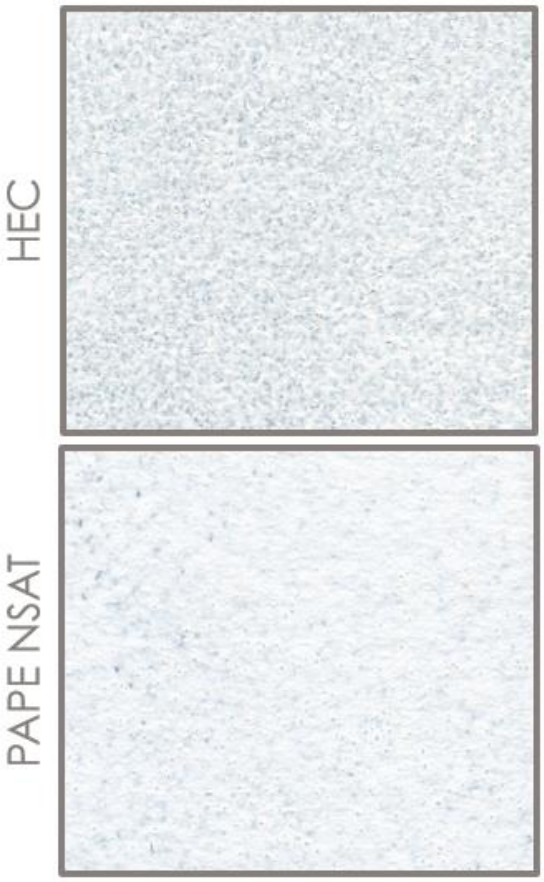
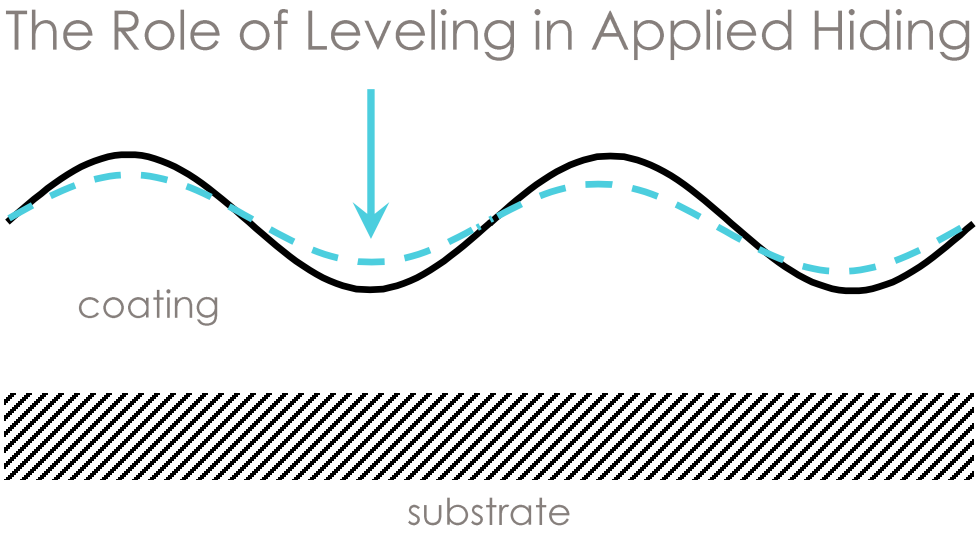
improved visual hide benefits





- deeper brush marks/roller stipple will reduce hiding
- more uniform film thickness will improve hiding

29 PVC, 29 VS VAE semi-gloss paint
flat black primed drywall with 3/8" nap roller cover

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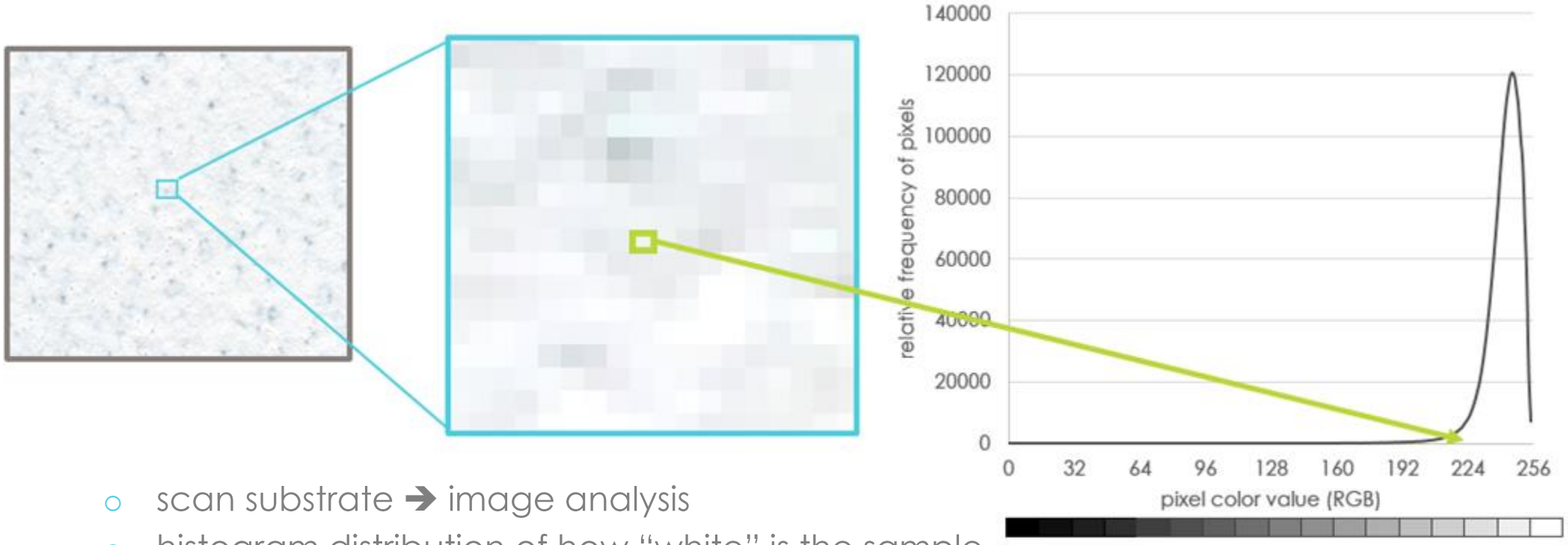
pixel analysis



- scan substrate ➔ image analysis
- histogram distribution of how "white" is the sample
- quantifiable and more reliable measure to aid product development and benchmarking
- used to also analyze surface defects
  - foam
  - pick spots

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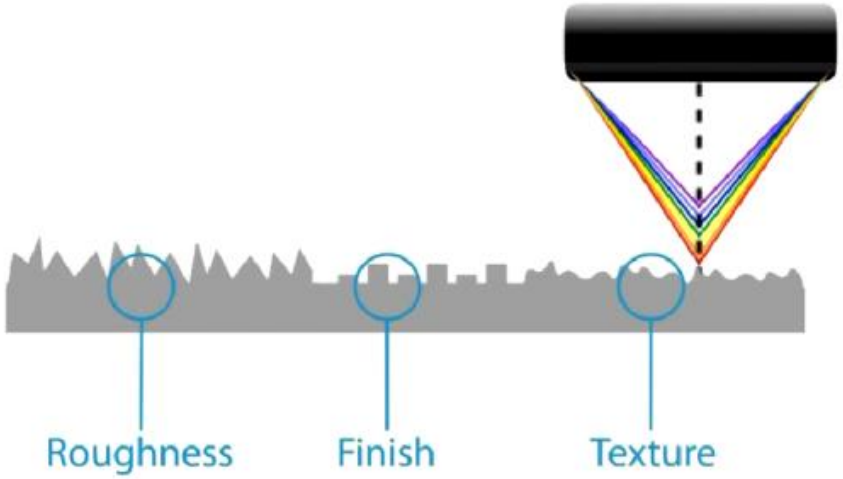
surface profilometer

Nanovea ST500

automated XY-stage – 40cmx20cm scan area
scan speed: 200mm/s
line scanner: Z-range 0-1000 mm, (80nm Resolution)



- non-contact method based on axial chromatism technique
- each separate wavelength will re-focus at a different height
- software quantifies various surface roughness parameters

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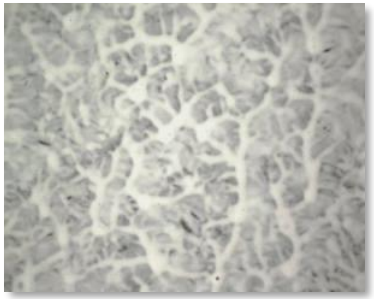
nap pattern characterization

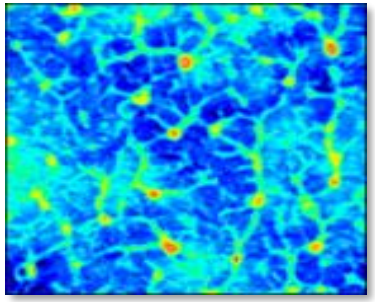
high resolution scanner

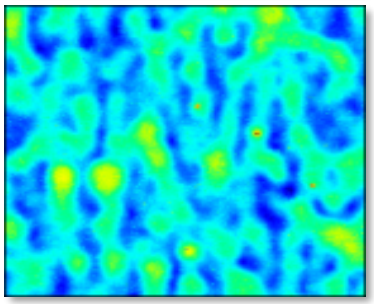


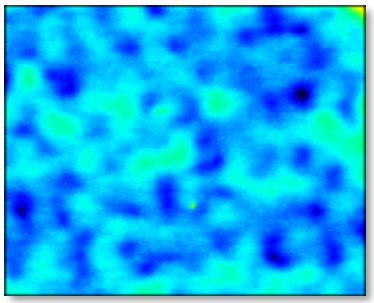
EXTREME LOOSE

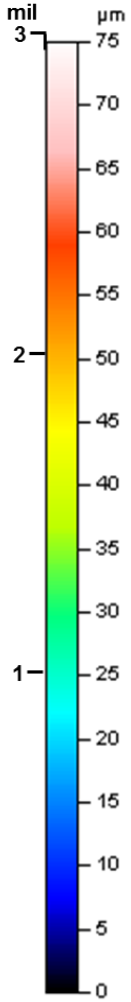
LOOSE

TIGHT & UNIFORM









surface profilometer

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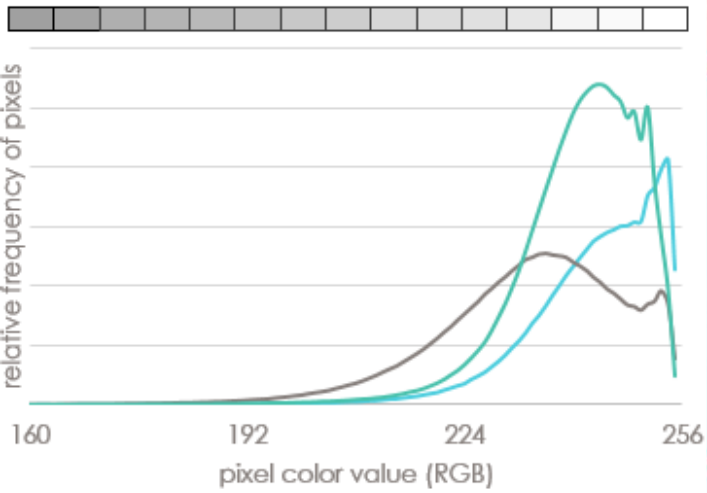
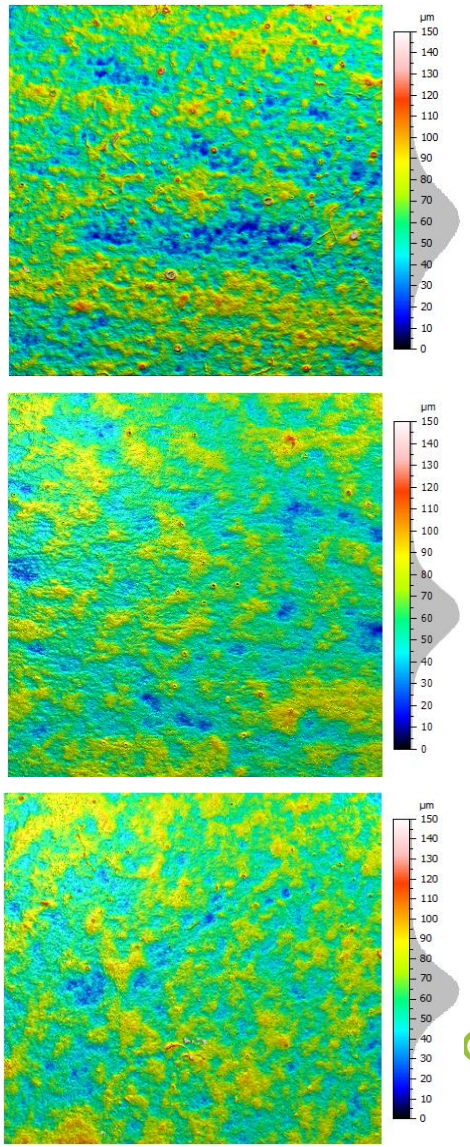
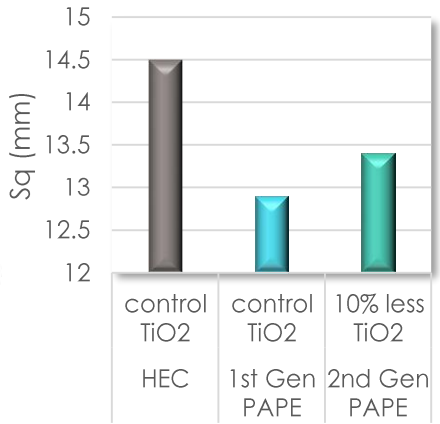
reduced TiO_2 application performance





surface roughness



- paint with PAPE NSAT is whiter than HEC thickened paint
  - narrow distribution of pixels towards #256

lower Sq value indicates smoother surface

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conclusions

- different chemistries and thickening mechanisms can control paint performance from wet application to dried appearance
- rheology modifiers play a key role in developing in-can feel and application properties resulting in superior applied hide
- visual improvements to applied hide properties can be characterized and quantified with analytical techniques to reduce subjectivity of visual measurements

Paint properties can be tailored by careful selection of the rheology package!

acknowledgements

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- Golden Gate Society for Coatings Technology

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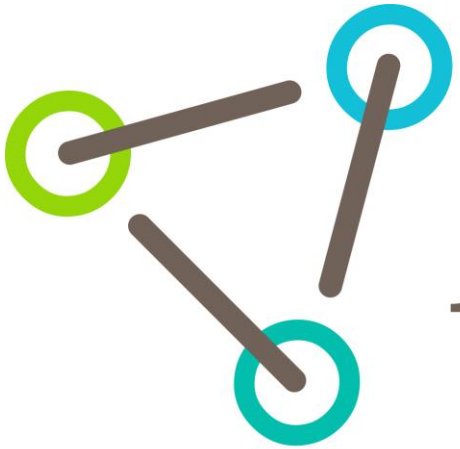

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