How to Achieve One-Coat, High Hiding Power Paints by Optimizing Titanium Dioxide Pigments

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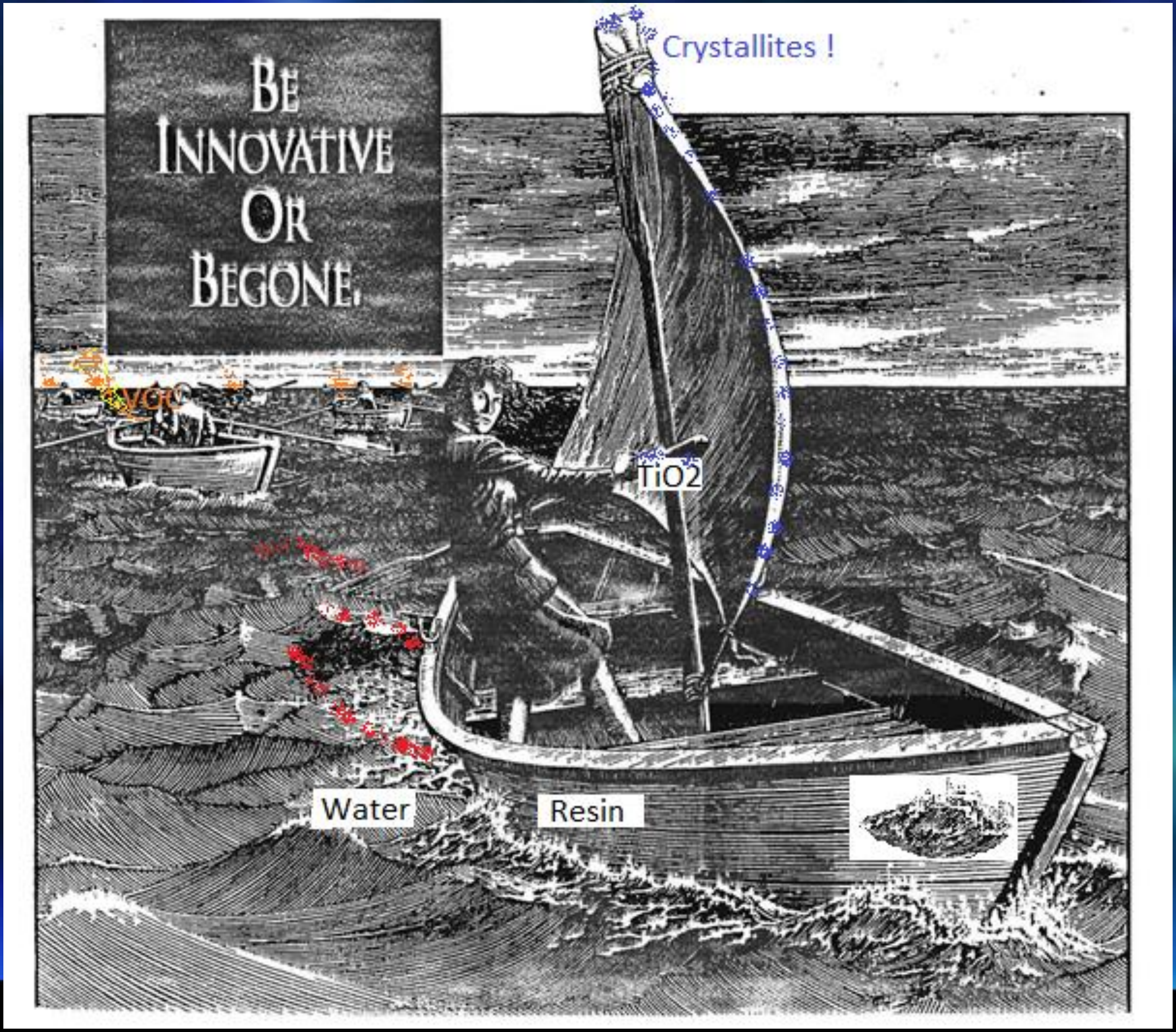
Basic Paint : Water, Resin & TiO_2



TiO_2 Optimization in Low VOC Paints, Promises Better:

- **TiO2 Grades / Extenders**
- **Dispersion**
- **Zeta Potential**
- **Particle Size**
  - **Instrument Pay Back in 3 months!**
- **Gold Standard**

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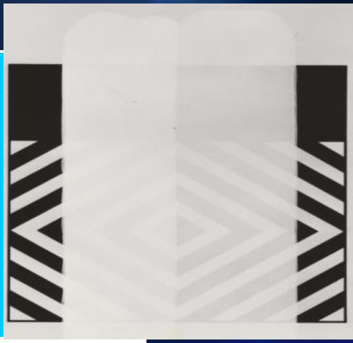
TiO2 Quality Certificate of Analysis

(If you don't't' ask, you don't get)

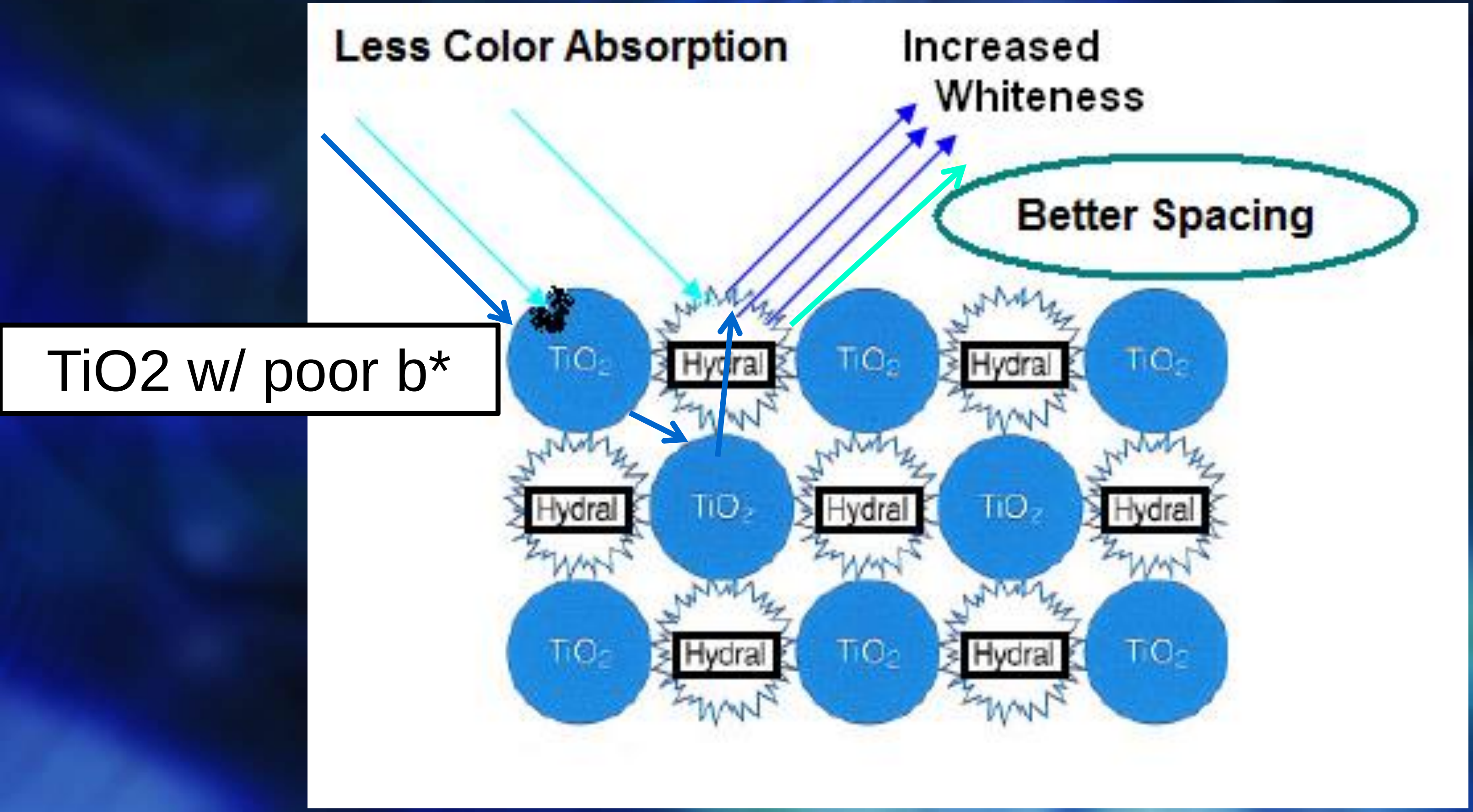
1. **Particle Size Distribution (PSD)**
2. **GSD (Geometric Standard Distribution)**
3. **% Greater than 0.5 um**
4. **Compare to Gold Standard (GS)**
5. **Nibs or Scatts and distribution**
6. **Slurry Solids (76%)/pH**
7. **Rheology**
8. **Grit (wt.%)**

Effect of % TiO_2 (alumina treated) on Hiding

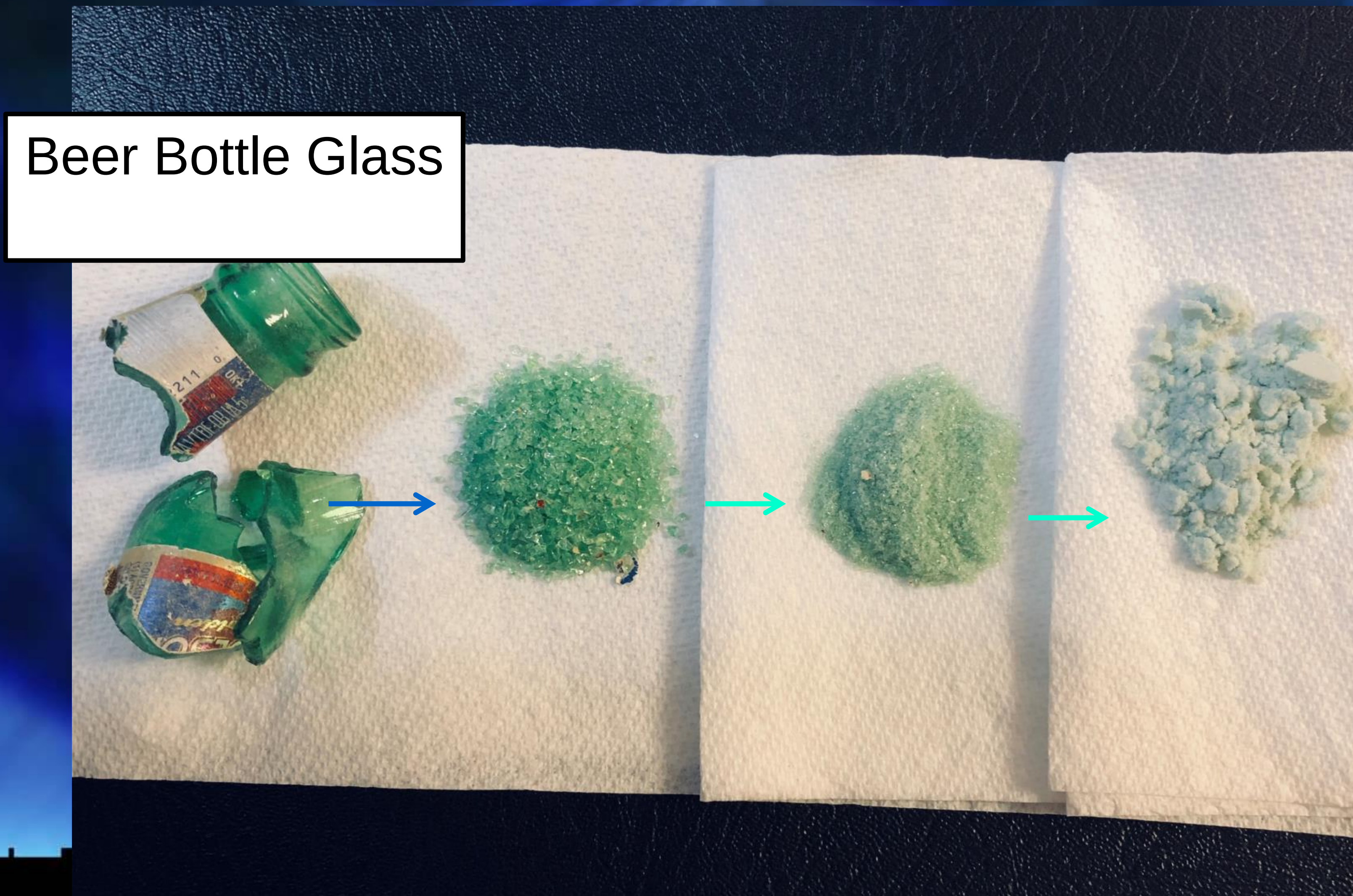


% Min. TiO_2	Oil Abs. (lb/ 100 lb)	20º Enamel Gloss	Average Hiding Low PVC	Average Hiding High PVC	Relative Chalk Resistance	Use
95	12	70	100	90	Good	General – High gloss
91	13	67	95	100	Very Good	Universal Interior/ Exterior
89	17	60	90	95	Excellent	Exterior Durable
80	32	45	85	115	Good	Flat

High Opacity & Whiteness by Spacing



Green Glass Loses Color and Becomes Whiter by Grinding & Sieving to 2mm 850 m → 177 μm → μ



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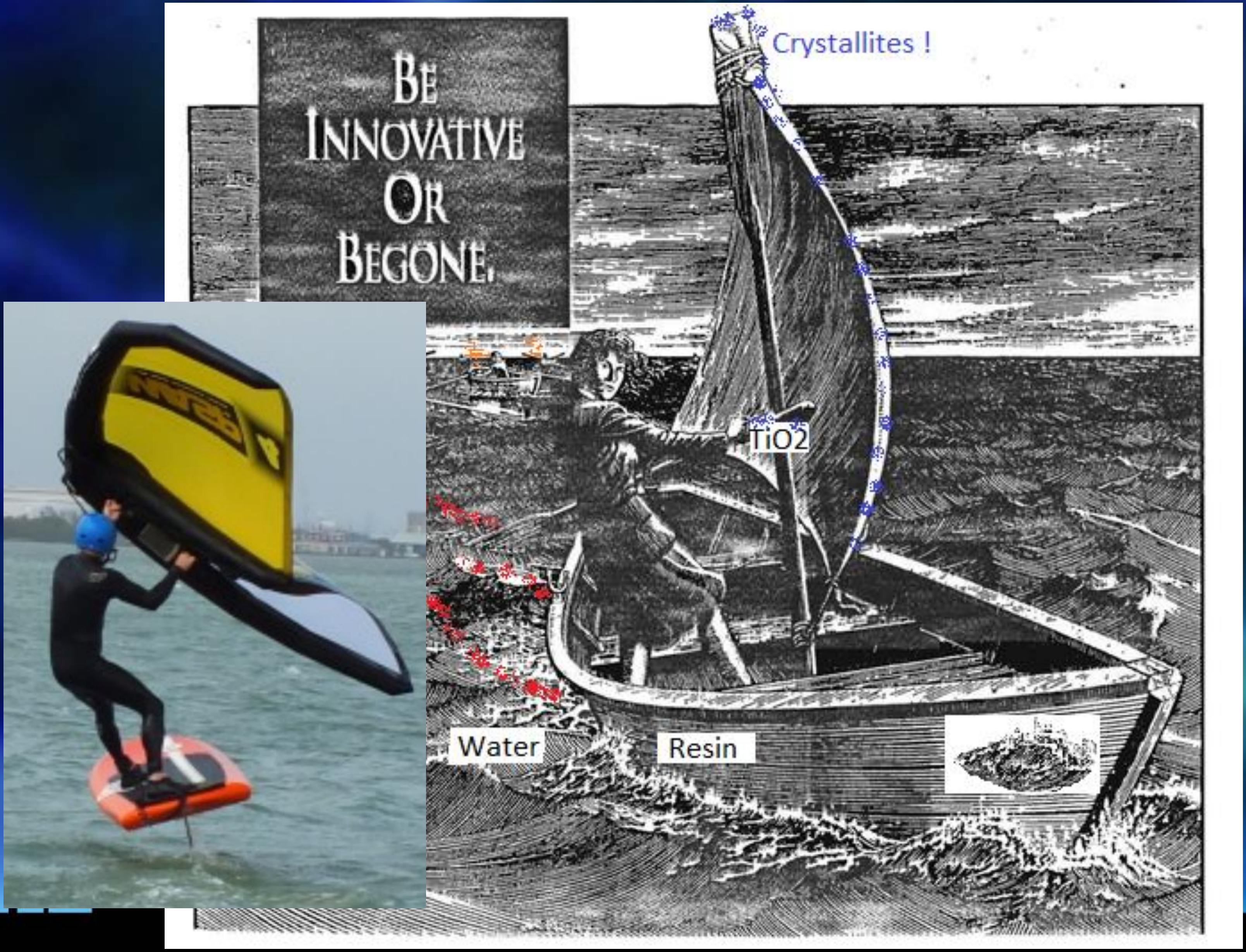
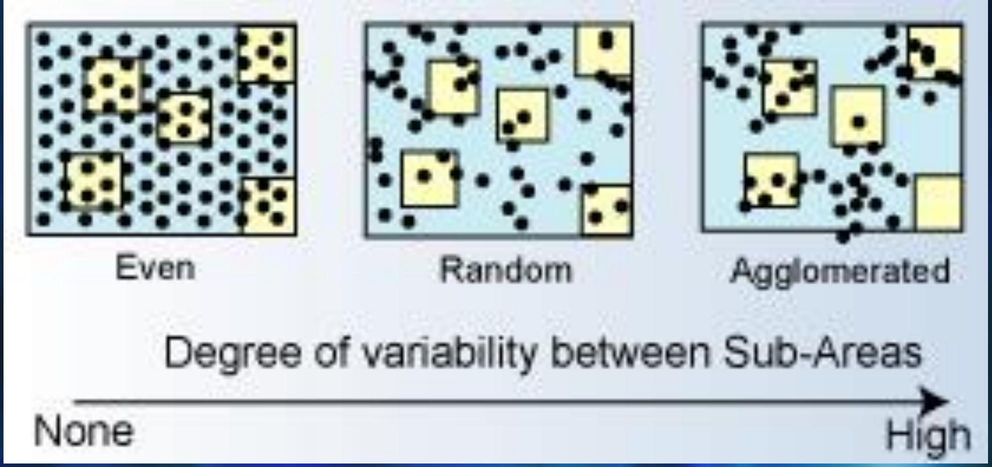
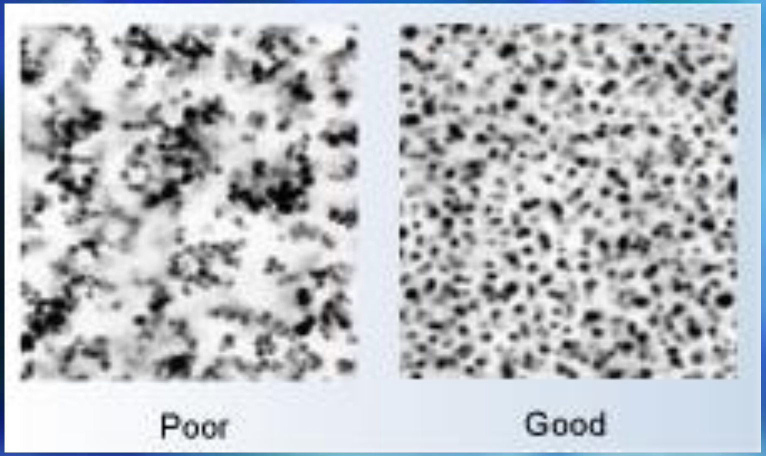


Ideal Dispersion is Better than Random

(Ref: Diebold (2005))





NEED Dispersion Dispersion Dispersion

- **BEST Dispersiple & Durable R706 type coating alumina/silica better than SuperDurable – eg Roof Coatings**
- **BEST Gloss**
- **Effects Tint Strength, Contrast Ratio, Hiding Power, Whiteness**

CHALKING

1. **Light Degrades Resin Binder**
2. **Works with water, acid rain, environmental deposits and UV**
3. **Worst case Oxygen Free in the film**

$TiO_2 \longleftrightarrow Ti(+4)O_2 + Ti_2(+3)O_3 + O_2$

a) Particle size CONTROLLED

Sulfate = Hydrolysis

Chloride = Oxidation/ Pressure

b) Grind: Steam /Pigment control

c) High density TiO_2 spacing

TiO_2 for Low VOC Paint

TiO_2 Grade #	Slurry Viscosity @ 80 wt. % (low Cp)	Particle % > 0.5 um (low %)	Median Particle Size & GSD	Draw Down Particle Size & # Particles (low #)	Resin & HEUR Comp.	Gloss (high)	Optical: Con. Ratio, Color Comp. & Tint S (high)
#3 GS	++	+	++	+	++	++	+
#3	-	-	0	--	0	-	-

Lab Equipment Need For TiO_2 Optimization

- **Zeta Potential / pH Meter**
- **Rheometer**
- **Particle Size Analyzer**

Zeta for TiO2 :

- In Paint: Avoid Dangerous pH Zones

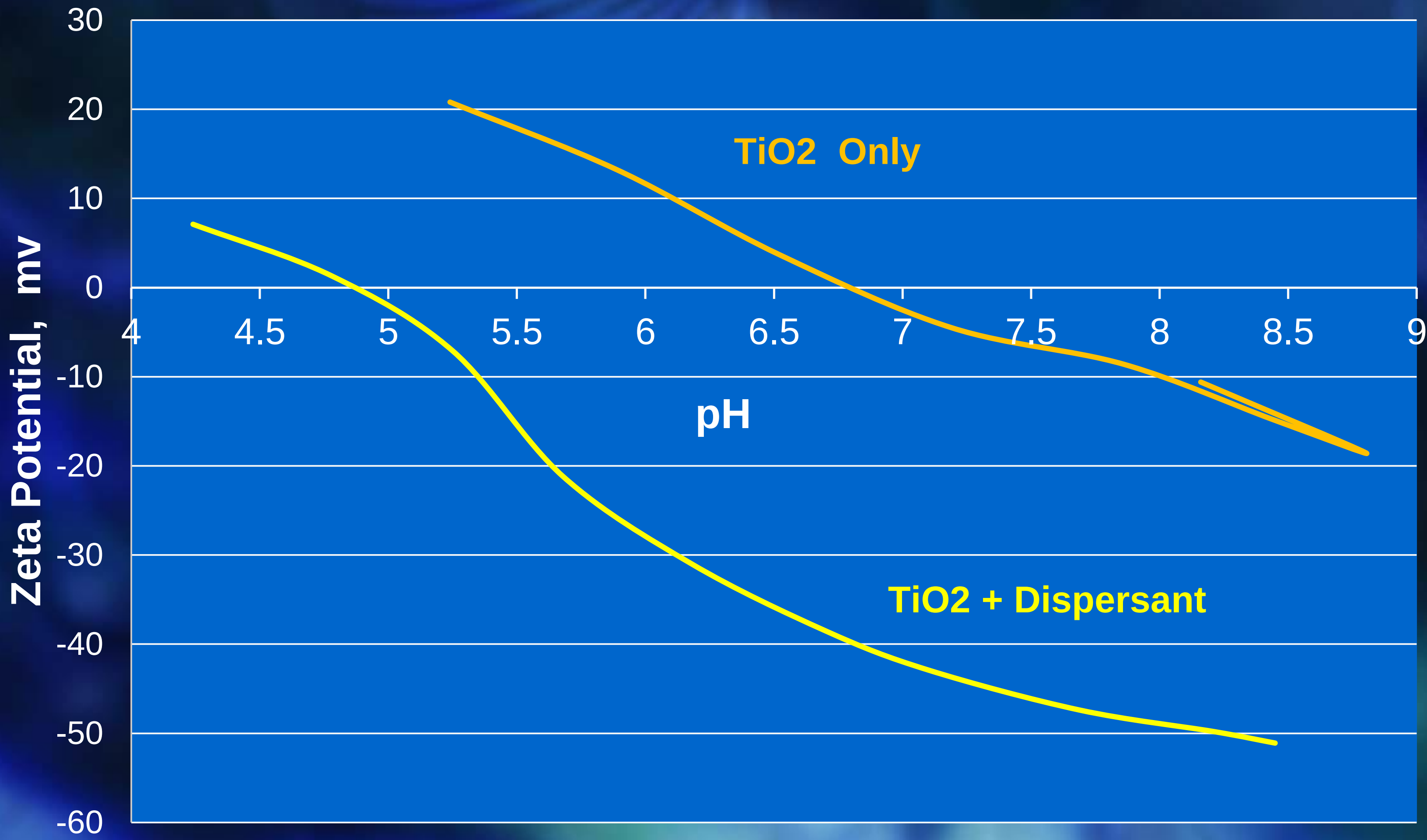
- In Pigment Grind: Shift IEP w/ Dispersants
  - Disperse Near IEP

Table 3—Characteristics of Different Surface-Treated TiO_2 Pigments[a]

Sample #	Isoelectric Point (IEP)	Surface Area (m^2/g)	Description of TiO_2 Pigments (Surface Concentration wt%)
1	9.0	15	$4.5\ Al_2O_3 \mid TiO_2$
2	6.3	15	$3.6\ Al_2O_3 - 6.5\ SiO_2 \mid TiO_2$
3	4.51	12.2	$1.25\ ZrO_2 \mid 2.0\ Al_2O_3 \mid 6.0\ SiO_2 \mid TiO_2$
4	6.36	14.3	$2.0\ Al_2O_3 \mid 0.5\ ZrO_2 - 2.0\ SiO_2 \mid TiO_2$
5	8.49	14.1	$2.0\ Al_2O_3 \mid 0.5\ ZrO_2 - 1.0\ Al_2O_3 \mid TiO_2$
6	8.28	15.0	$1.0\ ZrO_2 - 1.0\ Al_2O_3 \mid TiO_2$

(a) Surface composition of inorganic oxides is described according to the order of surface treatment, see text.

Universal Grade TiO_2 Slurry Zeta Potential as a Function of pH



Lab Equipment Need For TiO_2 Optimization

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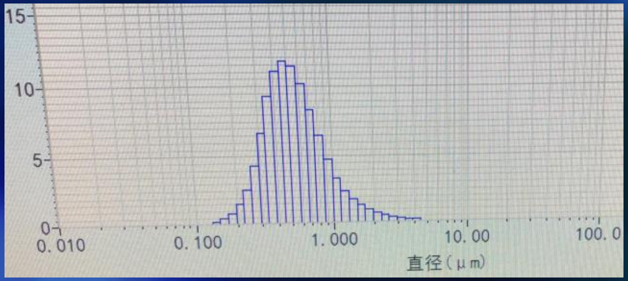
Horiba PSD Plots: iPhone Video Tracking
TiO2 Spacer Composite Agglomeration

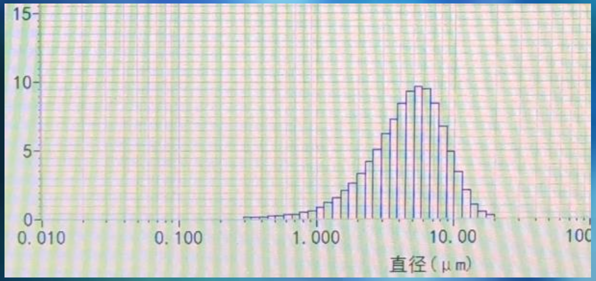
Effect of mixing TiO2 slurry with CaCO3 coated TiO2

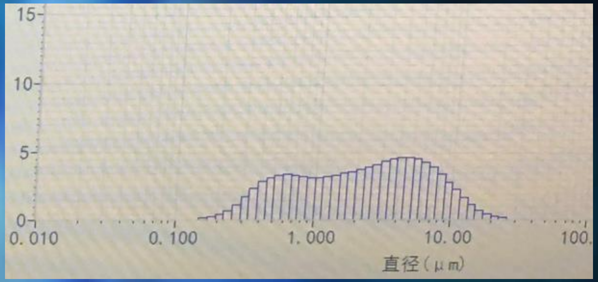
Demonstrate

- Real Time Particle Growth
- GSD Peak Broadening
- Final Finger Print

GSD 1.7 @ 0 min. GSD 2.2 @11 min. GSD 4.5 @45 min.





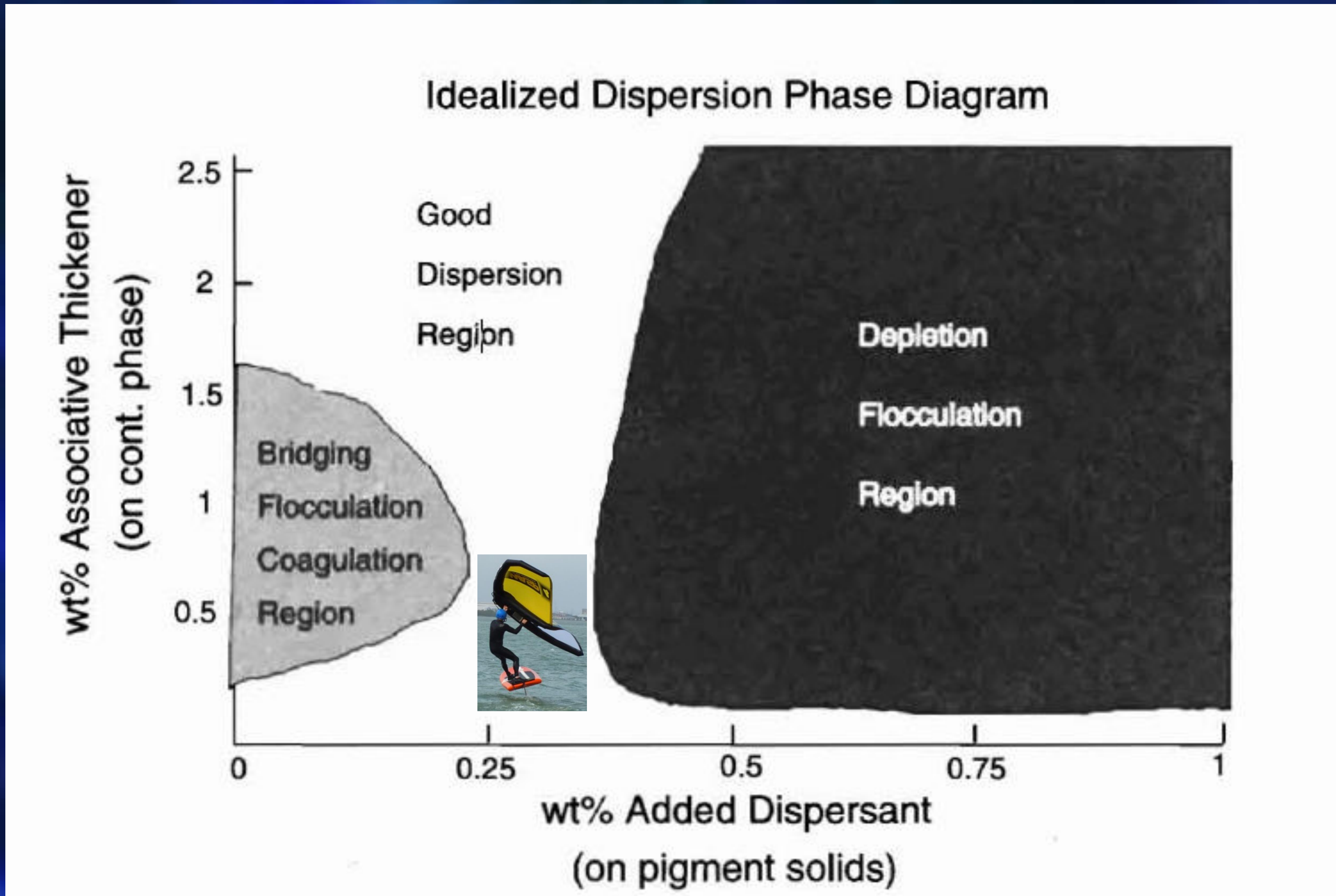


Two Types of Flocculation

1. **Bridging: Polymer Molecules Connect TiO_2 Particles.**

2. **Depletion: TiO_2 get squeezed out of the thickener solution**
   a) **Lower Gloss & CR**
   b) **Poorer Film Strength**
   c) **Poorer Adhesion**

Rheology Modifier / TiO2 Dispersant Phase Diagram



Great GSD needs a hydrophobic micro-codispersant (Helps Rheology Chemicals)

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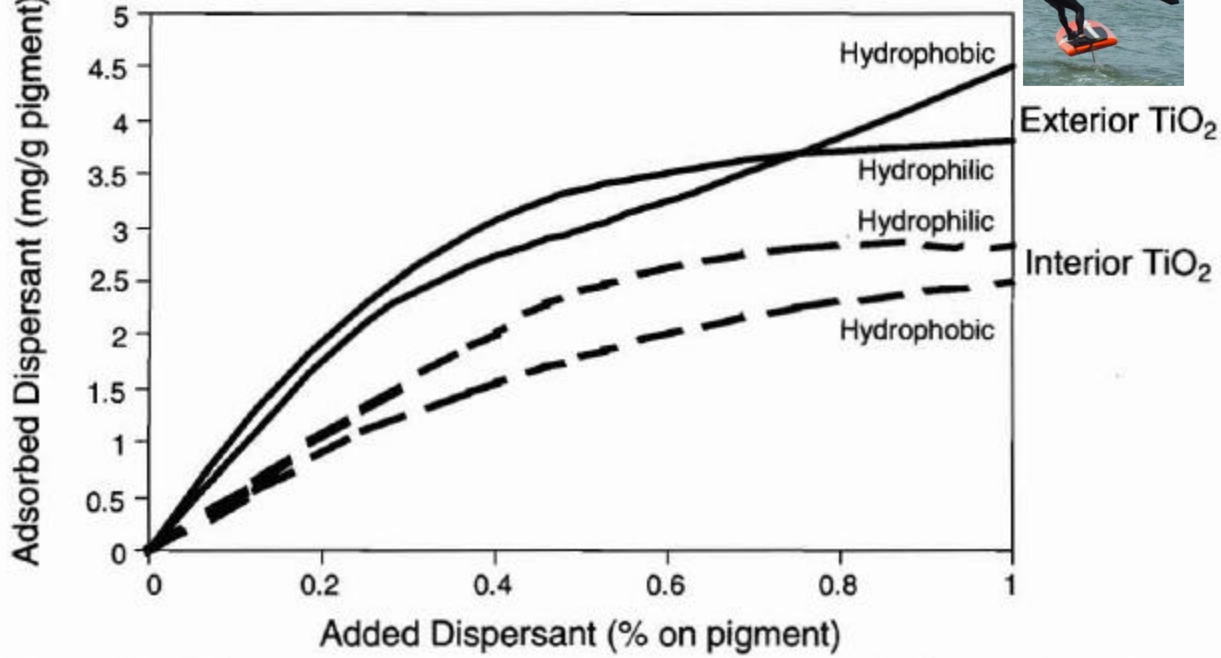
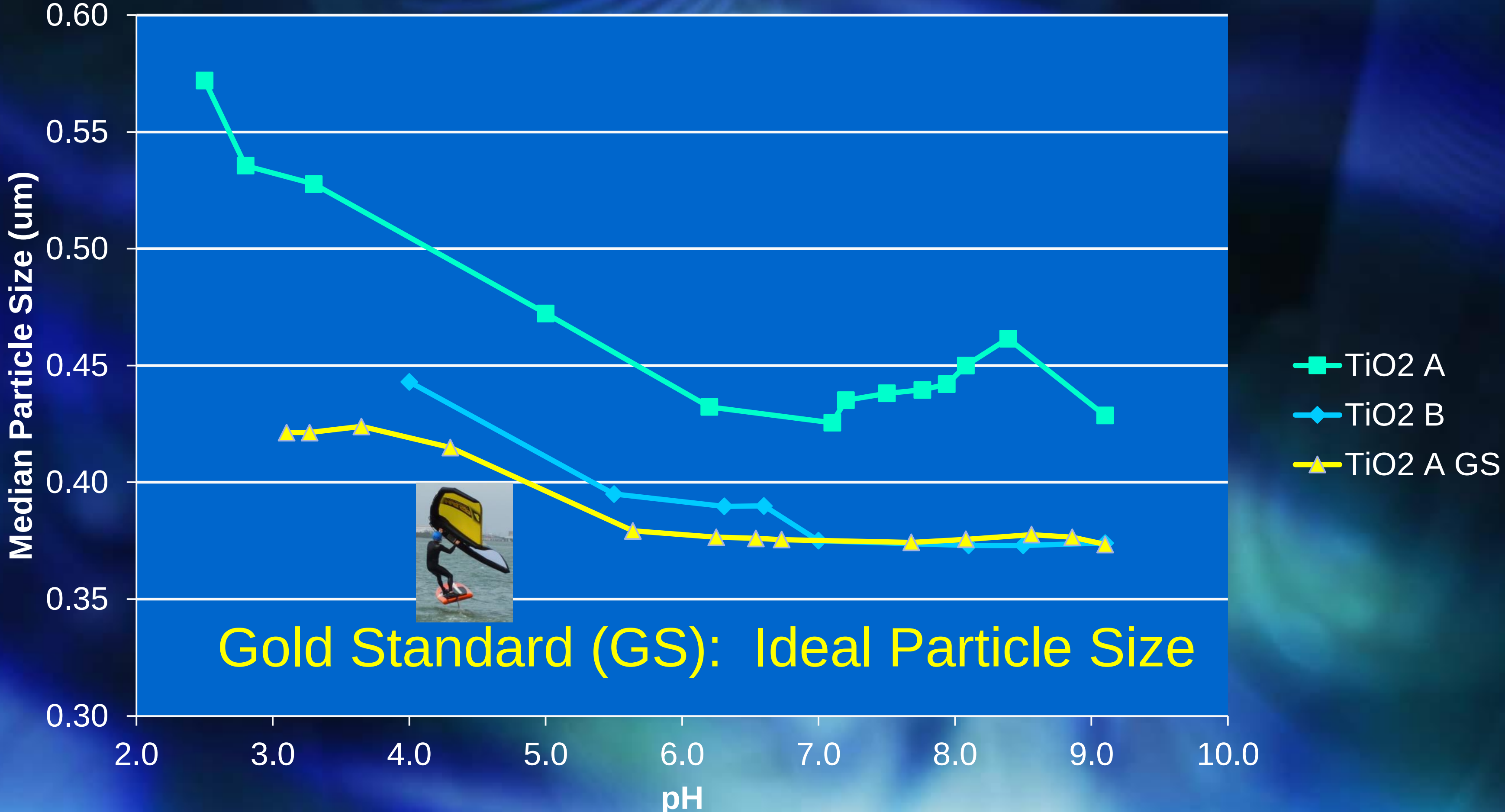


Figure 2—Adsorption isotherms of hydrophilic and hydrophobic dispersants on interior and exterior TiO_2. Exterior TiO_2 adsorbs more dispersant, probably because of a higher surface area. Surfaces are close to being saturated at the 0.6–0.8% dispersant level.

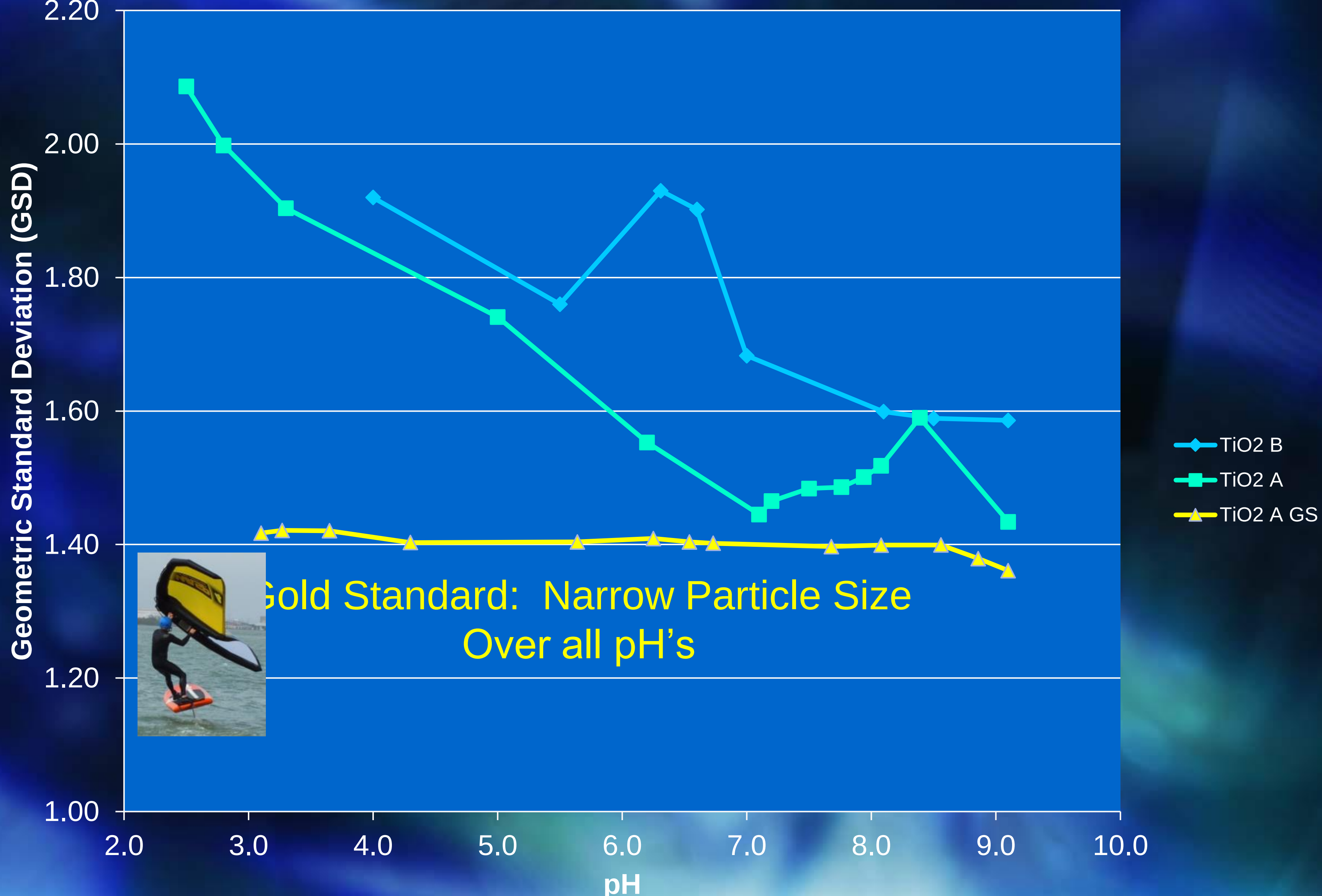
Effect of pH on TiO_2 Median Particle Size

(Better is < 0.4um, AMP-95 pH adjusted)



Effect of pH on TiO_2 Particle Size GSD

(Lower numbers are better, AMP- 95 pH adjusted)



High Opacity VOC Paints Requirements

- **Minimize Thickeners & Surfactants**

- **High Solids Filler Slurries**

✓ **Target : 70 wt. % solids (min.)**

- **TiO_2 Slurry Properties**
  1) **Small Particle Size vs. pH**
  2) **Narrow – GSD vs. pH**
  3) **Zeta Potential vs. pH**
  4) **High Solids / Low Viscosity: 380-480 Cp @ 79% Solids (Brookfield : #3 spindle, 100 rpm)**
  5) **Compatibility Tests & Phase Diagrams**