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RSC conference - Particle Dispersions in Liquid Formulations

Poster presentation – The importance of particle dispersions in paint formulations and the need for better characterization methods

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AkzoNobel Decorative Paints
16th December 2020

Abstract

Paints comprise dispersed particles of several kinds having wide ranges of particle size from tens of nanometres to hundreds of microns and a variety of shapes and aspect ratios. These include polymer latex particles and Titanium Dioxide white pigment at the smaller (colloidal) size end of the range, with near spherical shapes and mineral extender particles with largest particles of more than 100 microns and with diverse shapes from blocks to fibres and plates. Much R&D effort in the paint industry is spent on formulating to achieve stability of these complex dispersions, so that long product shelf-lives can be offered and so colours can be made accurately and reproducibly. Formulating work and problem solving usually takes the form of extensive designed experimentation and time-consuming stability testing. Attempts to gain deeper understanding and use more fundamental scientific approaches are hindered by the limitations of current characterisation methods, when it comes to complex, multi-modal, concentrated dispersions like paints, which typically have particle volume concentrations in the range of 20 to 50%.

Latex Paint as a complex dispersion

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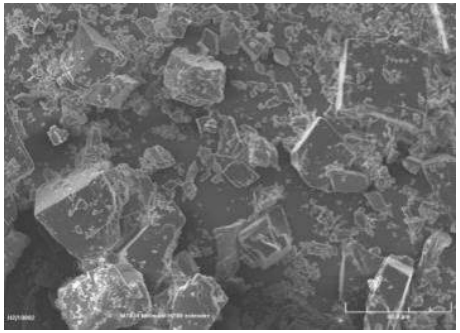
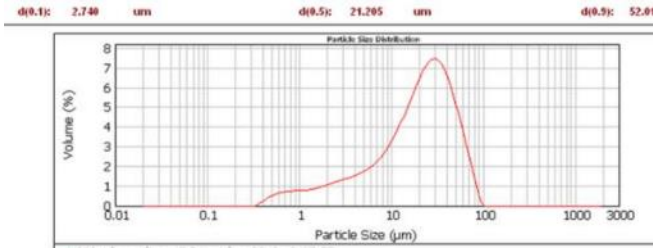
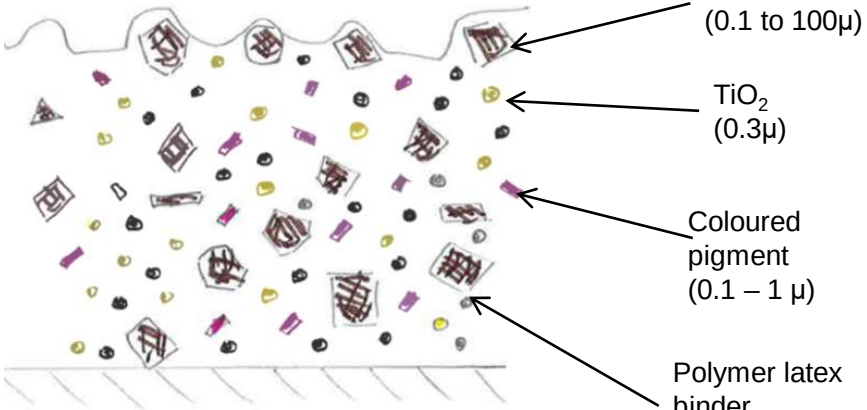
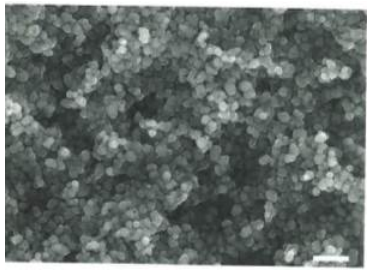
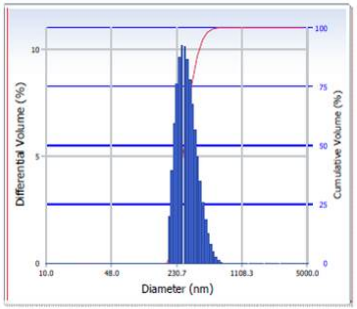


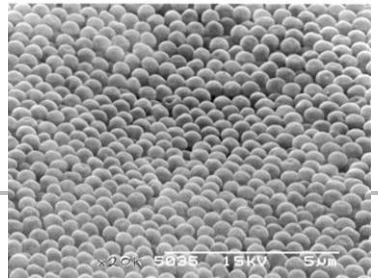




Applied wet paint film







How paint colours are made

- Most decorative paint colours are made using tinters, also called colorants.
- Tinters are concentrated dispersions of coloured pigments and extenders, with dispersants and other additives (e.g. humectants and rheology modifiers).
- Tinters are mixed into base paints to make each colour via defined ‘recipes’, which are the result of ‘colour matching’
- Base paints for pale colours contain white pigment, while those for deep colours generally do not.
- There are two routes for mixing tinters and base paints
  - ‘Ready-mixed’ or ‘factory’ colours
  - Tinters added during paint manufacture
- Post-of-sale tinted (POST) colours
  - Mixed with tinting machines in stores

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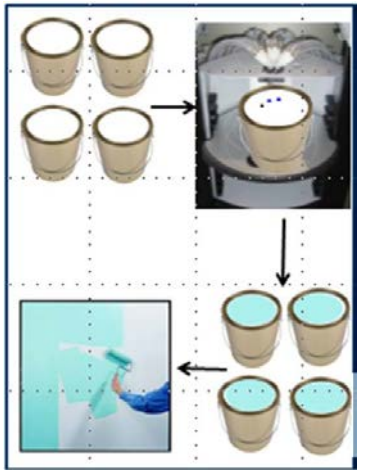

Importance of stable particle dispersions

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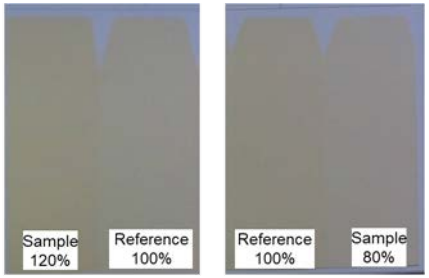
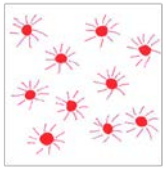
- Both tinters and base paints need to be carefully adjusted for ‘tinting strength’, to ensure accurate colours are made.
- Compatibility of the tinters and base paints and robustness to the mixing process are key requirements, which occupy a significant amount of R&D effort to get right.
- Base paints need to be stable on the shelf for several years.
- Tinters also need to be stable on the shelf, but in addition must be stable in-service in tinting machines
- To achieve stability paints and tinters are formulated with wetting agents, dispersants and surfactants.



Examples of strength reductions – Yellow tinter in white base paint.



Stable tinter dispersion

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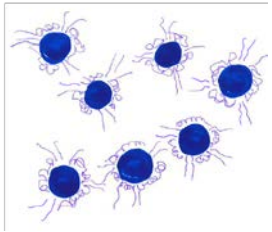

Stable base paint dispersion

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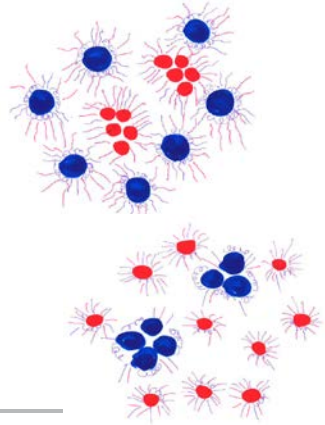
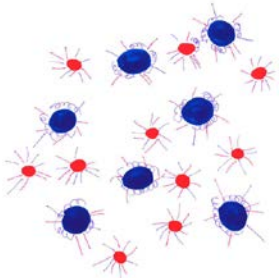
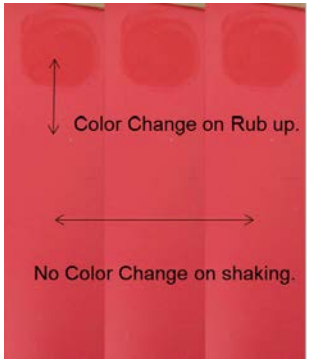


Flocculation of different pigments

OR



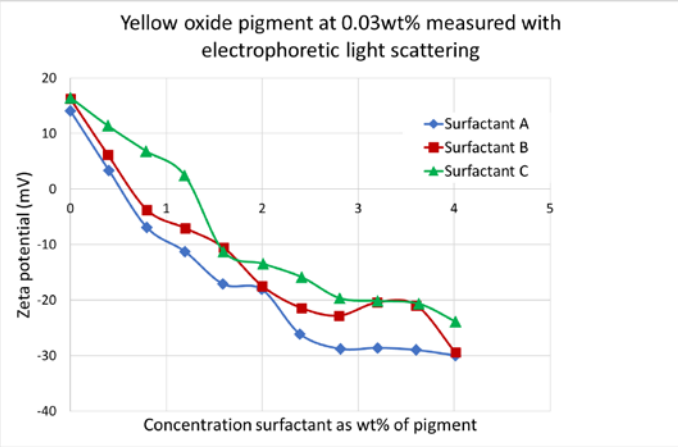
Stable paint colour

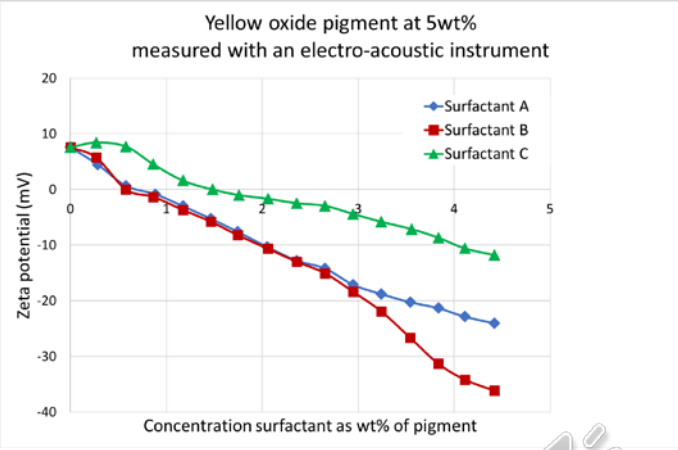


Issues with particle characterisation

- Particle dispersions in paint formulations are typically :-
  - Complex mixtures of different materials
  - Concentrated
  - Multimodal
  - Widely dispersed in size and shape

- Current commercially available methods cannot cope well with these features
  - Dynamic light scattering
  - Static light scattering
  - Microscopic methods
  - Acoustic methods





Example – Zeta potential for a yellow oxide pigment versus surfactant concentration, in two different concentration regimes, measured with an electrophoretic light scattering instrument and an electro-acoustic analyser. Reasonable agreement considering differences in the techniques and similar trends, but important differences in detail. The electro-acoustic method only gave reliable data up to around 20wt% of the pigment. (Data from Bogdan Ibanescu, AkzoNobel).