Characterization of Synthetic Latexes – Physical, Chemical, Colloidal and Morphological Properties

Day 1

AM

- **What does it mean to "fully" characterize a latex?**
- **Basics of creating synthetic latices**
    1. Particle nucleation and growth
    2. Control of particle size distribution
    3. Control of copolymer composition, MW, gel content
    4. Functional additives (esp. vinyl acids) and neutralization
    5. Residual monomer reduction
- **Latex applications**
    1. Coatings (architectural, paper, adhesive, textile)
    2. Thermoplastic impact modifiers
    3. Printing inks
    4. Cement and asphalt modifiers
- **Physical and colloidal properties of latices**
    1. Particle size distributions – techniques, comparisons, limitations. Homo- and copolymers. Multi-phase particles. Mono- and bimodal latices
    2. Problem solving

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- **Physical and colloidal properties of latices**
    1. Particle shape – SEM, TEM, AFM
    2. Particle density – monomer type, water content, composite particles
    3. Surfactant adsorption and coverage, CMC
    4. DLVO theory – charge interactions, non-ionic surfactants, titration procedures
    5. Competitive adsorption between ionic and non-ionic surfactants
    5. Electrophoresis – Zeta potential
    6. Colloidal stability (CCC, Maron, Waring blender)
    7. Establishing surfactant adsorption isotherms

Day 2

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- **Glass transitions, T_g**
    1. Dynamic mechanical analysis (DMA)
    2. Differential scanning calorimetry (DSC)
    3. Homo- and copolymers – characteristic shapes of transitions through the glass point
    4. Flory-Fox, Ponchon, Gordon-Taylor equations
    5. "Wet" T_g. Measurements and contrast with "dry" T_g. Water and organics as plasticizers.
- **Minimum film formation temperature (MFFT)**
    1. Instrumentation and operating conditions
    2. Reading the boundary
    3. Relationships between MFFT and T_g.
- **Latex viscosity**
    1. Rheometers – simple, sophisticated
    2. Real and "apparent" viscosities
    3. Newtonian and shear thinning viscosity
    4. Which viscosity is important?

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- **Chemical Properties**
    1. Overall polymer chemistry –
        - a.) Composition – average and distribution, NMR, FTIR
        - b.) MW – average and distribution, viscometry, GPC
        - c.) Orthogonal chromatography for CCD and MWD
    2. "Regional" chemistry
        - a.) Surface chemistry – surfactant adsorption, initiator end groups
        - b.) Functional monomers (e.g. AA– distribution in serum and in/on particles (titration techniques)

3. Branching and crosslinking

- a.) Sol – solvent extractions, characterization of sol polymer
- b.) Gel – solvent swelling index NMR (solid state) for branch points
- c.) DMA of films

4. Grafting

- a.) Selective extraction, – grafting efficiency, number of graft sites
- b.) Solid state NMR
- c.) MWD of sol (GPC),

5. Residual monomer content – GC, HPLC

- **Serum phase characterization**
  - a.) Separation of serum phase by centrifugation or filtration
  - b.) Serum replacement techniques
  - c.) Water soluble polymer (overall overall MW)
  - d.) Individual chain identification – liquid chromatography, mass spectroscopy

Day 3

AM

- **Structured Particles – Morphology**

1.) General considerations – what details are we looking for?

2.) External shape - SEM, AFM, soft and hard particles, surface chemistry

3.) Internal structure

- a.) Phase separation within particle – thermodynamics, kinetics
- b.) Extent of phase separation – quantitative assessment via DSC, DMA – qualitative assessment via TEM
- c.) Polymer-polymer interfaces within particles
- d.) Comparisons between “as is” and thermally annealed samples
- e.) Polymer-polymer de-mixing within particles

4.) Problem solving

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- **Structured Particles - Morphology**

5.) Location of the polymer phases within the particle

- a.) AFM (height and phase modes)
- b.) TEM (***whole particle***) – staining for phase contrast, soft particles, particle edge effects, false positives
- c,) TEM (***sectioned***) – embedding resins (epoxy, latex), sectioning, chemical staining (e.g. Os, Ru, PTA)
- d.) Minimum domain sizes, interfacial regions, phase ratio constraints, false positives

6.) TEM – EELS techniques

7.) STXM – X-ray microscopy

8.) The need for “complementary” data sets

9.) Problem solving

- **Review of important concepts**

- **Open discussion of questions from participants**