Morphology Evolution During the Drying of Polyurethane Dispersions for High-Performance Coatings

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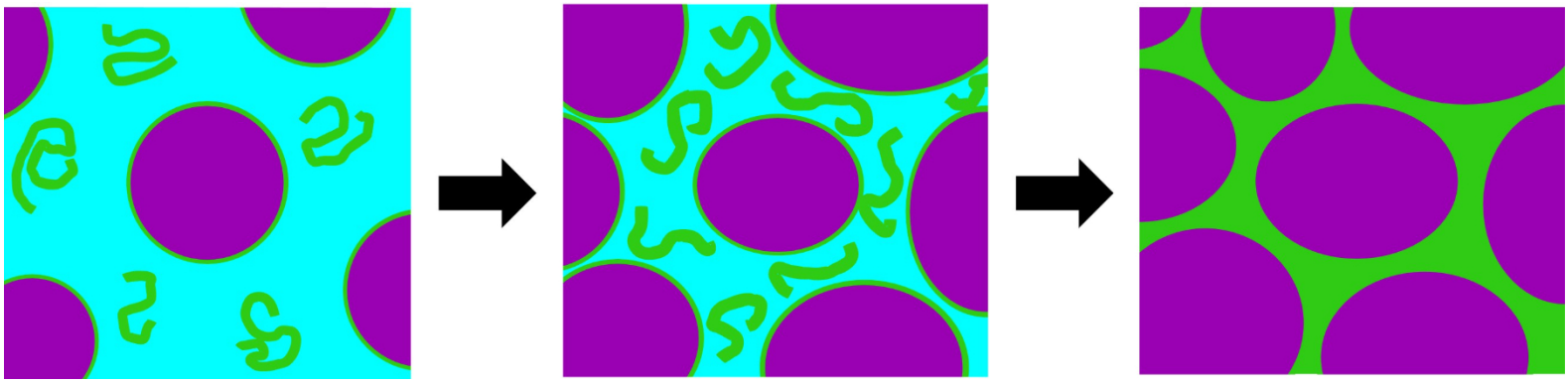
The morphology of resin dispersions plays a crucial role in the film formation and performance of waterborne coatings. Small angle X-ray scattering (SAXS) is a crucial technique for revealing these morphologies as the dispersions transition from liquid to dried films. It has recently been reported that polyurethane dispersions (PUDs) synthesised via the pre-polymer process can contain a two-population system: spherical PU particles and a secondary phase of hydrogen-bonded hard-block oligomers forming supramolecular structures.[1]
At high concentrations, SAXS patterns of these PUDs exhibit up to three pronounced peaks driven by complex interparticle interactions. These features map perfectly to a dual-population system, representing sphere-sphere, supramolecular-supramolecular, and cross-particle interactions. These observations can be accurately fitted using a model that incorporates mass balance and all three interactions into a single structure factor using a modified solid-spheres interaction solved by a Percus-Yevick enclosure.[2 3]
In-situ SAXS measurements during the drying of PUDs (varying in hard-block percentage and soft-block molecular weight) reveal that correlation distances between neighbouring particles decrease throughout film formation. However, complete particle coalescence is prevented by the minor population of acid-rich supramolecular structures aggregating at the particle interfaces. As confirmed by AFM, this results in a distinctive honeycomb structure: soft-block PU particles embedded within an acid-rich hard-block matrix.

Keywords:
SAXS, X-rays, polyurethane, dispersions, colloids, AFM,



Structural morphology evolution during the drying of a polyurethane dispersion, showing PU particles (purple) with acid rich interfaces (green), and a second population of supramolecular structure (also green).

References:

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