DECORATIVE COATINGS UNDER INVESTIGATION - PARTICLE SIZE AND PARTICLE SIZE DISTRIBUTION IN EMULSIONS ASSESSED BY AF4-MALLS-UV-RI, CF3-MALLS-UV AND DLS

Ashwell C. Makan[a, b], Markus J. Spallek[c], Madeleine du Toit[a], Harald Pasch[b]

[a]Kansai Plascon Research Centre, Polymer Science Building, Room 2028, University of Stellenbosch, Matieland, 7602, South Africa (acmakan@sun.ac.za)
[b]Department of Chemistry and Polymer Science, University of Stellenbosch, Private Bag X1, Matieland, 7602, South Africa
[c]Postnova Analytics GmbH, Max-Planck-Strasse 14, 86899, Landsberg, Germany

ABSTRACT

Emulsion polymers, mainly lattices form an integral part in the final film forming properties in water-based decorative coatings. The particle size and particle size distribution (PSD) of the final latex affects mechanical strength, adhesion, film forming, drying times, rheological and optical properties. Characterization techniques for accurate determination of particle size are therefore required for detailed interpretation and correlation of emulsion particles to structure property relationships. Dynamic light scattering (DLS) was used as a fast screening technique to determine the average particle size of emulsions synthesized via free radical polymerization. A pure acrylic emulsion polymerization was continuously sampled from the reactor vessel and subsequently analyzed to determine the particle size of the lattices throughout the polymerization reaction. Asymmetric flow field-flow fractionation (AF4) as well as centrifugal field-flow fractionation (CF3) was used to further investigate the evolution of particle size and its distribution as the polymerization progressed. Both FFF separation systems were coupled to concentration sensitive (UV, RI) and multi-angle light scattering detectors (MALS). Furthermore, styrene- and pure acrylic emulsions were mixed with inorganic species used in decorative coatings such as TiO_2. These complex mixtures of species were analyzed to investigate the behaviour under AF4 run conditions featuring a pure eluent-filled flow-streamline in an unpacked-channel thus minimizing adsorption and shear degradation effects commonly observed by using packed stationary phases (SEC). The flow AF4 system was coupled online to inductively coupled plasma mass spectrometry (ICP-MS) for elemental speciation and identification of the TiO_2 species. Both FFF techniques complemented one another and proved to be an ideal tool for the investigation of particle size and PSD of emulsions, as well as for the separation of complex organic-inorganic mixtures used in the coatings industry.

Identification of inorganic species separated from organic species in paints can lead to long sample preparation times and the use of multiple analytical techniques. Asymmetric Flow Field flow fractionation (AF4) is a novel tool which can be used for the separation of complex mixtures of species in coatings. Pure acrylic- and styrene acrylic emulsions were mixed with TiO_2 to investigate the behaviour of such a complex mixture in an AF4 environment. The AF4 system was coupled to a concentration (UV) and multi-angle laser light scattering (MALLS) detector to obtain particle size information of both the emulsion and TiO_2. Furthermore an inductively coupled plasma mass spectrometer (ICP-MS) was coupled online to AF4 for identification of the TiO_2 species.

In both of the pure acrylic and styrene acrylic mixtures, the emulsion particles could be sufficiently separated from the TiO_2 species by AF4. Additionally the TiO_2 could be positively identified via the ICP-MS detector. AF4 proved to be a useful separation technique for the separation and identification of complex organic-inorganic mixtures used in coatings.