Synthesis and Characterization of Hybrid Nano-silica Waterborne Polyurethane based on Natural rubber

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Abstract

A novel hybrid waterborne polyurethane (HWPU) based on natural rubber (NR) was successfully synthesized in a two-step process by polyaddition reaction and followed by a sol-gel reaction of (3 -Aminopropyl) triethoxysilane (APTES). The bio based-polyol used in this work was issued from natural rubber, by epoxidation of NR latex in situ using performic acid, and successive controlled degradation using formic acid and hydrogen peroxide (1) . The so obtained oligomers had a molecular weight of 3,500 g/mol and dispersity 1.98. They were modified at the chain ends with hydroxyl groups and in the backbone by grafting APTES, via a sol-gel reaction (2). The formulation to obtain hybrid waterborne polyurethane was optimised after addition of silica nanoparticles, and thick PU films were prepared. The effect of silica content (the average particle size of 20 nm.) in the range 0 – 15% wt. was investigated. The nano-sizer was used to measure the particle size distribution, and the shape morphology of the dispersion was characterized by transmission electron microscopy. The HWPU had good stability for more than 6 months. The HWPU/silica films showed lower surface gloss units with increasing nano-silica content. The water contact angle increased with increasing the nano-silica content, showing that the silica particles are present also at the surface of the films and make it more hydrophobic. Moreover, the water absorption of HWPU/silica decreased as the amount of nanosilica increased. These results confirmed that the water repellence or anti-wettability of HWPU film was improved by adding nano-silica content. In addition, EDX-SEM results confirmed an excellent dispersion of the silica particles in the HWPU matrix. Adding nano-silica showed effective reinforcement in HWPU to improve the tensile strength. The HWPU/silica with high nano-silica content required high activation energy to start the breakage of the backbone of polymer chains, indicating that HWPU/silica films with high nano-silica content are more thermally stable. The investigations showed that the new way to prepare HWPU/silica films based on natural rubber via sol-gel process was effective with enhanced performance for a coating application, supporting

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the concept of eco-friendly materials.

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