Design of Layered Double Hydroxide based nanocomposites: from colloidal particles to nanocomposite films

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In nanocomposites, the addition of anisotropic nanoparticles such as clay platelets acting as fillers in a polymeric matrix can induce a drastic improvement in properties including mechanical strength, toughness and gas permeation.[1] Among potential fillers, Layered Double Hydroxides (LDH) display unique anionic exchange properties that make them highly attractive in multiple domains. LDH are a class of readily synthesizable anionic layered materials that can be used as an alternative to the commonly used aluminosilicate clays for the preparation of polymeric nanocomposites.[2] In this presentation, we will focus on the recent developments on waterborne LDH nanocomposite particles for film formation.

Electrostatic interaction between positively charged LDH nanoparticles and negatively charged poly(methyl methacrylate-*co*-butylacrylate) (P(MMA-BA) latex were used to promote the adhesion of the LDH platelets on the latex surface. Because the P(MMA-BA) Tg is close to room temperature, film formation was performed at room temperature as currently reported in coatings applications. The level of fillers was easily varied from 5wt% to 30 wt%. Interestingly, at high LDH contents a continuous cellular arrangement of the LDH–rich layers concentrated at the latex particles interface is obtained.[3] In an alternative approach organic/inorganic latexes encapsulating LDH nanoparticles were also synthesized using a generic synthetic reversible addition-fragmentation chain transfer (RAFT)-based emulsion polymerization process. To this end, LDH were chemically modified by an appropriate macroRAFT agent carrying suitable carboxylic groups typically a random copolymer of acrylic acid (AA) and n-butyl acrylate (BA), synthesized in solution using trithiocarbonate compounds as RAFT agents. MacroRAFT agent-modified LDH nanoparticles were then used in the emulsion polymerization of hydrophobic monomers (a mixture of methyl acrylate (MA) and BA) in order to form the encapsulating shell. The morphology of the nanocomposite latex particles was characterized by (cryo-)TEM and correlated with the surface modification. The use of polymer latex particles-encapsulated anisotropic nanofillers appeared as an efficient approach to achieve spatial organization of inorganic particles into latex films and enhanced the mechanical properties. Systematically, the nanocomposite films were deeply investigated using a large panel of techniques (XRD, FTIR, TGA, FIB, TEM and DMA) with the aim to establish a relationship between film microstructure and mechanical properties.

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