NANOSTRUCTURED POLYMERIC HYBRIDS BASED ON ACRYLIC COPOLYMER

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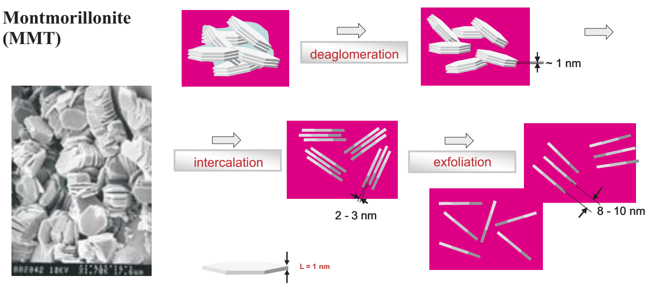
Layered silicate nanocomposites are an important class of polymer materials for which a large set of properties can be improved when compared with classical filled materials at the same filler content. They are characterized by the nanoscale dispersion of aluminosilicate platelets within a polymer matrix.
The improvement of polymer mechanical and permeability properties is of considerable significance from a point of view of polymer composite theory. Many approaches are used to achieve necessary tensile characteristics, including chemical crosslinking, irradiation, polymer composite and polymer blend processing and others. Enhancing the modulus and strength of polymer systems with the addition of silicate layered fillers and dispersion on nanoscale is one of the very promising ways used nowadays.

The nanocomposites were prepared by blending styrene-acrylate copolymer (SAC) with dispersed natural (MMT) and organically modified montmorillonite (OMMT). Different SAC nanocomposites with OMMT content from 0 to 15 wt.% were obtained. Influence of OMMT on the tensile stress-strain diagrams, elasticity, strength, elongation at break and the properties of water vapour barrier (diffusivity, solubility, and permeability) were investigated.

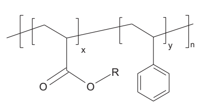
THEORY

Montmorillonite (MMT)



MATERIALS

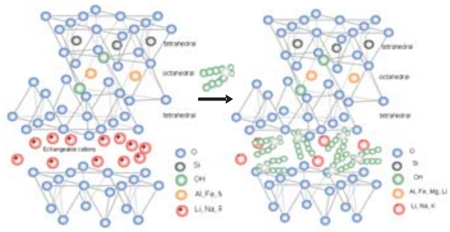
Aqueus dispersion of styrene-acrylate copolymer



R-methyl, ethyl, hydroxyethyl group

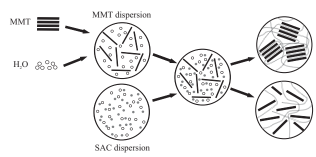
Solids content (ISO1625) = 50%
Viscosity (ISO3219) = 100 -400mPa.s
pH value (ISO1148) = 4-5

Montmorillonite (MMT) **OrganoMontmorillonite (OMMT)**

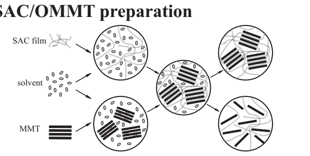


NANOCOMPOSITES PREPARATION

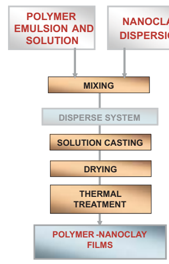
SAC/MMT preparation



SAC/OMMT preparation

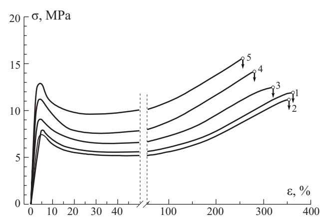


The nanocomposites were produced compounding the dispersions of MMT and acrylic copolymers in aqueous and organic solvent media.

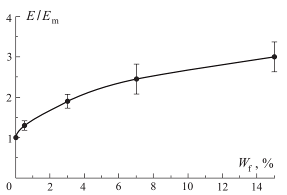


SAC/MMT

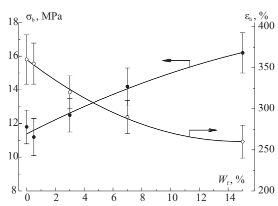
TENSILE PROPERTIES



Stress-strain curves for acrylic copolymer SAC (1), and nanocomposites with 0,5 (2), 3 (3), 7 (4) and 15 wt. % (5) of MMT.

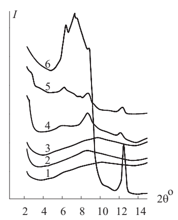


Ratios of elastic modulus E / E_m as function of the weight content W_f of MMT in nanocomposite.



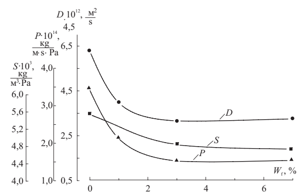
Tensile strength σ_b and strain at break ε_b as functions of the weight content W_f of MMT in the nanocomposite.

X-RAY DIFFRACTION



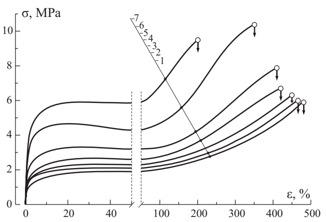
X-ray diffraction curves for unfilled SAC (1), nanocomposites containing 0,5 (2), 3 (3), 7 (4), 15 wt. % (5) of OMMT (7), and for pure MMT (6).

PERMEABILITY

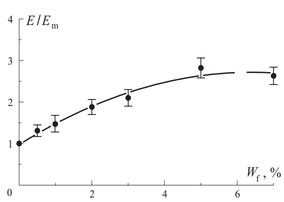


Coefficients of diffusion *D*, solubility *S*, and water vapor permeability *P* as functions of the weight content W_f of MMT.

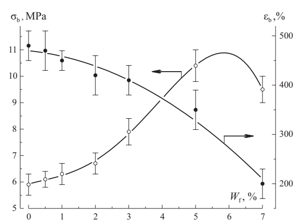
SAC/OMMT



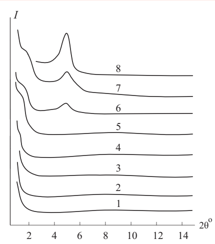
Stress-strain curves for unfilled SAC (1) and nanocomposites filled with 0,5 (2), 1 (3), 2 (4), 3 (5), 5 (6), and 7 wt.% (7) of OMMT.



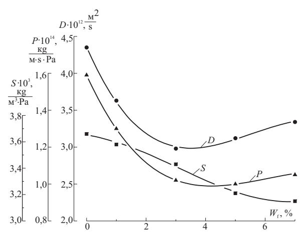
Ratios of elastic modulus E / E_m as function of the weight content W_f of OMMT in nanocomposite.



Tensile strength σ_b and strain at break ε_b as functions of the weight content W_f of OMMT in the nanocomposite.



X-ray diffraction curves for unfilled SAC (1), nanocomposites containing 0,5 (2), 1 (3), 2 (4), 3 (5), 5 (6), 7 wt. % of OMMT (7), and for pure OMMT (8).



Coefficients of diffusion *D*, solubility *S*, and water vapor permeability *P* as functions of the weight content W_f of OMMT.

CONCLUSIONS

Styrene-acrylate copolymer filled with MMT deforms as glassy state polymer with inherent yielding area that corresponds to necking and its subsequent development till failure occurs. In turn, SAC with OMMT is behaves more as rubbery polymer without any consiferable signs of yield maximum. The indices of mechanical properties of the prepared nanostructured materials are improved considerably with introducing a rather small content of MMT or OMMT into SAC matrix. With increasing concentration of nanoclay of both types, the tension diagams of the nanocomposite are shifted toward the region of higher stresses.
Observed, that improvement in nanocomposites diffusivity *D*, solubility *S* and permeability *P* to water vapours is believed to be contributed to increase in difusant molecule pathway tortousity.
High aspect ratio of the nanofiller, large contact area with the matrix, formation nanoscale interfacial regions with altered molecular mobility could be responsible for tensile and permeability property enhancement.

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[3] R.D.Maksimov, S.Gaidukovs, M.Kalnins, J.Zicans, E.Plume, A nanocomposite based on a styrene-acrlate copolymer and native clay 2. Modeling the elastic properties, Mechanics of composite materials, 2006, Vol.42, No.2., p.163-172.

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