NANOMATERIALS BASED ON INTERCALATED CLAY MINERALS

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Intercalates of montmorillonite with octadecylamine were synthesised using low-temperature melting procedure to obtain precursors for polymer nanocomposites. Results of the interlayer structure analysis show that observed values of interlayer spacing depends on the concentration of octadecylamine molecules in the interlayer. The spacing equal to 33 Å (monolayer arrangement) and 53 Å (bilayer arrangement) were observed for the following ratios of montmorillonite–octadecylamine = 100:75 and 100:150, respectively. The intercalation reaction is based on the ion–dipol interaction and the both interlayer species (Na^+ cations and polar molecules of octadecylamine) participate in the host-guest charge transfer. The values of calculated exfoliation energy confirmed the generally accepted opinion that the exfoliation is more easy for the bilayer arrangement of the guests and that the increase of the octadecylamine concentration decreases the exfoliation energy. Resulting montmorillonite–octadecylamine intercalate with the bilayer arrangement in the interlayer is a suitable precursor with low exfoliation energy for clay–polymer nanocomposite technology.

Nanoparticles suitable for clay–polymer nanocomposite were also prepared by exfoliation and disintegration of vermiculite powder (< 5 μm) using 30% hydrogen peroxide treatment. Significant reduction of the peak intensity of the 002 reflection was observed (there is only 14% of the intensity of non-treated sample) after treatment of the sample with hydrogen peroxide (30 minutes at 50°C). Reduction of the peak intensity of basal reflections is caused by disintegration of vermiculite particles and the hydrogen peroxide treatment is decisive for this process. We suggest at least two possibilities for fixation of peroxide in the Mg-vermiculite structure: a) intercalation of peroxide molecules into the interlayer (addition of peroxide molecules to water molecules), and b) substitution of H_2O_2 molecules for H_2O molecules. Combined thermal (at 50°C) and peroxide treatments cause the significant degree of Mg-vermiculite exfoliation and disintegration.

Crystallisation of nanoparticles of CdS in the interlayer "space reactor" of montmorillonite was performed and changes in the XRD and IR patterns were observed. Such intercalated system is related to the recent discovery that the photophysical properties of semi-conductors change with particle size. A shift of spectral absorption threshold was observed when CdS nanoparticles powder and montmorillonite intercalated with CdS nanoparticles were compared.