Inorganic-organic hybrids originating from organosilane anchored onto leached vermiculite

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The properties associated with some inorganic solids having organic guest molecules incorporated on the established inorganic layer through immobilization processes leads to new organofunctionalized compounds, which have attracted great attention from both scientific and practical viewpoints. In this context, the grafting involves organosilanes that enable covalent bond formations with available reactive surface groups. For example, a natural clay mineral, when reacted with a suitable organic species, yields a product with increased hydrophobization of the surface particles. Thus, the 2:1 clay minerals provide either silanol and aluminol groups on their surfaces, whose structural availability offer favorable condition to attach desirable pendant chains onto the inorganic framework, from the organosilane grafting process [1]. The ability to organofunctionalize leached vermiculite was investigated. For this purpose, samples of natural clay were treated with different nitric acid solutions of varying concentrations for 4 h at 368 K. In a typical procedure, a sample of raw vermiculite (50 g) was suspended in 500.0 cm$^3$ of acid solution for 4 h at 363 K. Nitric acid solutions with concentrations 1.0, 2.0, 3.0 and 4.0 mol dm$^{-3}$ were used. Next, 100.0 cm$^3$ of cold distilled water was added and the sample allowed to cool for 30 min. The suspension was filtered and dried at 383 K overnight. The samples were named Vm, where m = 1 to 4, corresponding to the sequence of the aqueous acid concentrations used. The lixiviation of sodium vermiculite produced the restructured porous solids with surface area over a wide range, varying from 133 to 673 m$^2$ g$^{-1}$. The precursor and lixiviated vermiculites were reacted covalently with silylating agent, 3-aminopropyltrimethoxysilane (N), to attach this agent onto the inorganic surface, through the free available silanols. The derivatives originating from leached vermiculite demonstrated a significant increase in the anchored organic groups, reaching 2.14 mmol g$^{-1}$ for V3-N, while the as-received clay showed a reduced value of 0.64 mmol g$^{-1}$. This is due to the new silanol groups formed, and the highest surface area of 673 m$^2$ g$^{-1}$ for V3, against 16 m$^2$ g$^{-1}$ for the original clay. This result clearly indicates that the leaching treatment strongly influenced on the reactivity of the original vermiculite. Other characterizations were based on infrared spectroscopy, X-ray diffraction, nuclear magnetic resonance in the solid state for carbon and silicon. The success of this investigation is directly related to the leaching of the natural vermiculite, which is strongly influenced by the reactivity of the abundant original source. The knowledge obtained on handling such types of inorganic material is of great significance for success in the synthetic procedure of polymer/layered silicate nanocomposites, to improve the properties and to provide useful extractable natural products.

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