Chemical Treatment of Montmorillonite and Kaolinite for Synthesis of Carbon Nanotubes

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Abstract. This paper deals with the deposition of carbon nanotubes on montmorillonite and kaolinite. Prior to synthesis, the minerals were chemically treated by particles of iron. The resulting deposits on Fe-impregnated montmorillonite and kaolinite were monitored in terms of morphology. The high catalytic efficiency of montmorillonite samples is related to the presence of large amounts of Fe^{3+}, as ion exchange reactions occur in which the original exchangeable cations are replaced by Fe^{3+} cations. These are trapped not only in the interlayer space and on the basal surfaces but also on the edges of the crystals, and in addition there are also Fe^{3+} cations located in the internal structure of the mineral. Kaolinite has other properties – inability of intracrystalline swelling, negligible surface charge of silicate bilayers and almost zero cation exchange capacity. Carbon nanotubes were present on the edges and fracture surfaces of the kaolinite crystal, while the planar surfaces remained uncovered. We reproducibly verified that the catalytic effect is unambiguously linked to the presence of iron. The presence of excess iron has a positive effect on the growth of more carbon nanotubes in Fe-montmorillonite. In the case of Fe-montmorillonite and Fe-kaolinite, we observed a unique phenomenon, namely cross-bridging of the particles by carbon nanotubes. Carbon nanotubes outgrew the entire volume of both types of substrates giving rise to three-dimensional networks.