Efficient adsorption of Rhodamine B onto a synthetic nano-talc: Towards the understanding of an unexpected process

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Introduction

Synthetic clay minerals of nanometric dimension are layered solids that offer unique control over the chemical structure and physical aspect. Their combination with organic dye molecules leads to organo-mineral hybrids that can be tailored to promote specific optical properties.[1] Since 2006, our team has elaborated a new synthetic talc (ST) under hydrothermal conditions.[2] This mineral shares some similarities with natural talc, in particular the lamellar tetrahedral-octahedral-tetrahedral (TOT) structure. It also has several distinctive features such as its submicronic size (Fig.1a), hydrophilic behaviour and chemical purity. Moreover ST shows strong and unprecedented adsorption potential towards charged organic dye molecules.[3,4] This behaviour is particularly intriguing because non-swelling clays like talcs do not contain exchangeable cations, and are therefore known to interact very weakly with organic molecules.

Materials and Methods

In this work, the interaction between ST and Rhodamine B (RhB) was thoroughly analyzed using complementary analytical techniques (XRD, NMR, IR, electron microscopy, UV-visible absorption and fluorescence spectroscopies). In particular, equilibrium data acquired at various temperatures were fitted to access the thermodynamic parameters.

Results and Discussion

Very stable organo-mineral hybrids were prepared (Fig.1b and c). The presence of ST induced an increase of the fluorescence intensity together with a bathochromic effect with respect to pure water (Fig. 1d). It was shown that the dye molecules adsorb both at the nano-talc surface and on the edges. The edge/surface ratio and the number of crystal defects played a key role. The nature of the interactions was clarified.

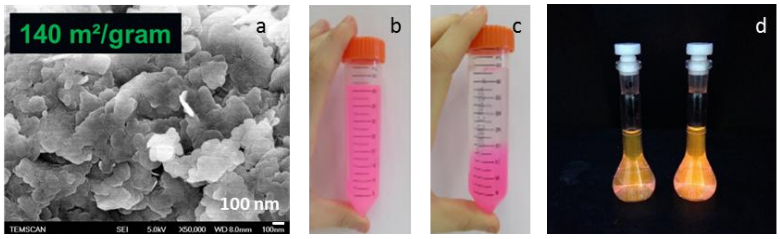

Figure 1: a) Scanning electron microscopy image of ST. b) Suspension of ST in the presence of RhB. c) Formation of a stable gel after centrifugation. d) Emission of RhB in pure water (left) and in the presence of ST (right), under illumination at 365 nm. [RhB] = 5.5×10^{-6} M; ST: 19.2 mg/L.

Conclusion

The elaboration of such nanocomposites is easy, cost-effective and versatile. This study opens a new route towards optical brighteners, cosmetics and fluorescent polymers.[4] Applications could also be found in the fields of paper milling, inks and depollution.

Bibliography

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