11th International Conference
on Advanced Materials

Rio de Janeiro Brazil
September 20 - 25

ICAM2009

Preparation and Characterization of Bentonite Clays Modified with Vanadium Pentoxide

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Abstract – The idea of the interaction of inorganic gels with clays has as its objective the generation of new hybrid colloidal materials that possess electronic and ionic conductivity. This conductivity is promoted by conducting wires of inorganic gels, which physically adhere to metallic surfaces, forming layered films. In this work, the preparation, characterization and electrochemical properties of nanocomposite material prepared by the combination of vanadium pentoxide ($V_2O_5.nH_2O$) and Bentonite clay (montmorillonite) are described. The material was characterized by X-ray diffraction, thermogravimetric analyses, UV-Vis and IR spectroscopy, scanning electron microscopy and cyclic voltammetry.

The development of nanocomposite materials has opened frontiers for the preparation of new materials with predetermined characteristics. The intercalation processes, and the adsorption of the species through the sol-gel process to yield inorganic solids, constitute examples of experimental procedures used to get well-controlled dispersions of selected species, which lead to the formation of nanocomposites [1-3].

The sol-gel materials possess great efficiency as surface modifiers, which can sometimes be easily manipulated and be distributed to get layers, films or coverings in the most diverse types of substrates, such as glasses, metals, polymers, etc. The vanadium pentoxide sol-gel, when dry, forms a layered solid with high structural flexibility, making possible the insertion or intercalation of another chemical species [1-2].

The interaction of the inorganic gels with clays increases the electronic and ionic conductivity of the clay material. This fact is explained by fibrils of the gel of vanadium pentoxide that remain unbroken after the interaction, acting as a conducting wire.

In this work, the preparation, characterization and electrochemical properties of nanocomposite material prepared by the combination of vanadium pentoxide ($V_2O_5.nH_2O$) and Bentonite clay (montmorillonite) are described. The material was characterized by X-ray diffraction, thermogravimetric analyses, UV-Vis and IR spectroscopy, scanning electron microscopy and cyclic voltammetry.

The XRD data, in which it can be observed that the basal distance of the mixed material is greater than that of the pure Bentonite, indicating possible intercalation of the gel between its layers. The nanocomposites present a very low degree of crystallinity that is characterized by very wide and low-intensity diffraction peaks. The SEM images showed that they exhibit fibrous structure, in contrast with a structured flat surface characteristic of pure Bentonite.

The results of cyclic voltammetry with a modified electrode were consistent with the redox pair V^{+5}/V^{+4} obtained by other methods. In conclusion, vanadium colloidal nanocomposite has possible applications for electrochemical devices such as electrochromic devices and amperometric sensors, as well as catalysts.

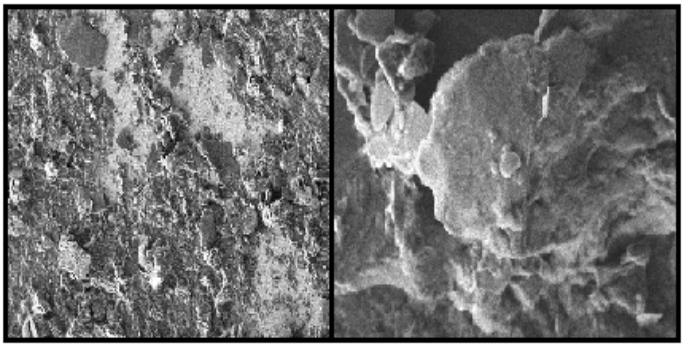

Figure 1: SEM image of a film of BV: a) 500x, b) 2.200x.

References

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