11th International Conference
on Advanced Materials

Rio de Janeiro Brazil
September 20 - 25

ICAM2009

Preparation and Characterization of Nanocomposites Based on Colloidal Nickel and Laponite Clay

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Abstract – In this work, the preparation, characterization and electrochemical properties of nanocomposite materials prepared by the combination of colloidal nickel and laponite clay (hectorita) are described. The material was characterized by X-ray diffraction, thermogravimetric analyses, UV-Vis and IR spectroscopy, scanning electron microscopy and cyclic voltammetry. The results indicate the formation of materials that are easily processable as thin films, and containing electrochemically active nickel colloidal, with potential applications in electrochemical devices such as batteries, electrochromic windows and amperometric sensors.

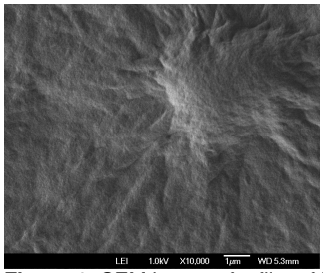
The properties of composite materials largely depend on the homogeneity and interfacial area, as well as shape, size and orientation of the minor components in the matrix. In this context, colloidal systems and gels are especially interesting materials for the preparation of nanocomposites. Vanadium pentoxide gels have such properties and has been exploited for the preparation of many intercalation composites with molecular and oligomeric components, leading to the formation of nanocomposite materials with interesting mechanical, optical, thermal and physico-chemical properties [1-2].

In this work, the preparation, characterization and electrochemical properties of nanocomposite materials prepared by the combination of colloidal nickel and laponite clay (hectorita) 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 shown in Table 1 and Figure 2, shown an increase in the basal distance of nanocomposite as compared with pure laponite, but is not consistent with intercalation of nanoparticles in the interlamellar space. However, the interaction with colloidal $Ni(OH)_2$ lead to a significant decrease of crystallinity or reduction of the laponite platelets, as indicated by the rather broad X-ray diffraction peaks. Interestingly, the SEM images showed that they exhibit fibrous structure, in contrast with a non-structured flat surface characteristic of pure laponite. The nanocomposites were electrochemically active, exhibiting CVs consistent with α-$Ni(OH)_2$. Interestingly, no significant changes were observed in the CVs even after hundread cycles, indicating stabilization of α-$Ni(OH)_2$, showing potential application in electrochromic devices and amperometric sensors.

Table 1: 2θ values and corresponding basal plane distances for Laponite and LapNi composite.

Laponite			LapNi		
2θ	**d(Å)**	**n**	**2θ**	**d(Å)**	**n**
5,90	15,01	1	5,78	15,36	1
19,73	4,48	3	17,90	4,93	3
27,84	3,17	5	27,62	3,20	5
35,15	2,51	6	---	---	---
53,83	1,65	9	---	---	---
60,88	1,45	10	---	---	---



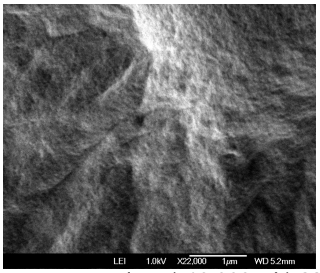


Figure 1: SEM image of a film of LapNi nanocomposite: a) 10.000x, b) 22.000x.

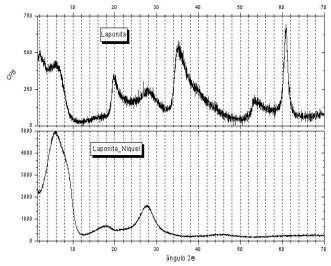


Figure 2: XRD of Laponite Clay and LapNi (below).

References

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[2] Unates, M.E.; Folquer, M.E.; Vilche, J.R; Arvía, A.J.. *J. Electrochem. Soc. 139*, 2697, 1992.