

Investigation of a Novel Hybrid Material Comprising Hexaniobate and Chitosan

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Abstract - A gel-like material containing layered niobate intercalated with tetraethylammonium (TEA) ions was mixed with chitosan solutions having a niobate:chitosan mass proportion of (1:1), (1:2), (1:5), (1:10) and (1:20). X-ray diffraction (XRD) patterns indicate the isolation of materials containing chitosan intercalated between the niobium oxide type matrix. This new hybrid material can be more compatible with other organic species than the pristine niobate, opening new opportunities for applications.

In recent years, hybrid materials have been largely investigated due to the improvement of physical, chemical and mechanical properties, and their versatile applications. The possibility to make use of natural resources together to layered compounds contributes to get eco-friendly materials [1].

Layered hexaniobate, $K_4Nb_6O_{17}$, consists of octahedral units of NbO_6 , which form a two-dimensional layered structure *via* bringing oxygen atoms. The layers are negatively charged and K^+ ions occupy the interlayer region to maintain the charge neutrality. There are two types of interlayers (I and II) that have different properties of hydration and ions exchange [2]. To obtain organic-inorganic materials, it is necessary to modify the interlayer region by decreasing the electrostatic interaction between the niobate chains and the positive ions using specific exfoliation agent and experimental conditions to get delaminated particles [3].

In this work, it was investigated the formation of hexaniobate-chitosan materials using different mass proportions aiming to isolate hybrid structures more compatible with organic species such as polymers than the pristine niobate. $K_4Nb_6O_{17}$ was prepared by ceramic methods at high temperature and changed to acidic phase, $H_2K_2Nb_6O_{17}$, through an ion exchange reaction. A fixed amount of acidic niobate was suspended in TEAOH solution with molar ratio (TEAOH/hexaniobate- H^+) equal 0.50 and maintained under stirring at room temperature for one week. The formed gel-like dispersion was washed, centrifuged and mixed with 250 mL of water. The suspension was divided in five flask and chitosan solution was added in order to match the hexaniobate:chitosan mass proportions of (1:1), (1:2), (1:5), (1:10) and (1:20). All suspensions were stirred at room temperature for three days. Elemental analysis (CHN) confirm the presence of chitosan in the niobate samples and an increase of the amount of organic species intercalated with the raise of the mass proportion. XRD pattern of the hexaniobate-chitosan (1:20) shows the presence of one phase with the series of (0*kl*) peaks at 2.33 nm (d_{020}), 1.13 nm (d_{040}), 0.765 nm (d_{060}) (Figure 1). Considering the layers expansion compared to the acidic phase ($d_{040} = 0.80$ nm), it can be concluded that the chitosan intercalation really occurred. Other characterization techniques (infrared spectroscopy and scanning electron microscopy) were used to investigate the hybrids structure.

References

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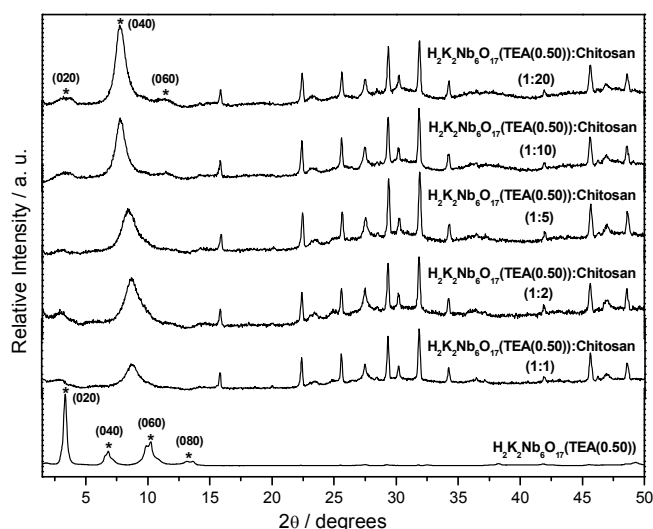


Figure 1: XRD patterns of $H_2K_2Nb_6O_{17}(TEA(0.50))$ and $H_2K_2Nb_6O_{17}(TEA(0.50))$:Chitosan with the mass proportion (1:1), (1:2), (1:5), (1:10) and (1:20).