ELECTRONIC TRANSPORT IN $WO_3.H_2O$: A DIELECTRIC SPECTROSCOPY STUDY FROM 1kHz TO 10 GHz

L. Beluze [(a,b)], J.C. Badot *[(a)], R. Weil [(c)], N. Baffier [(a)]

(a) ENSCP, LCAES, UMR CNRS 7574, 11 rue P. et M. Curie, 75231 Paris Cedex 05, France
(b) LRCS, UMR CNRS 6007, 33 rue Saint Leu 80039 Amiens, France
(c) Supélec, LGEP, UMR CNRS 8507, 91190 Gif sur Yvette, France

The recent interest in studying the electrical properties of $WO_3.H_2O$ was stimulated by its promise as regards use as a material in devices for infrared reflectance modulation [1]. The electrochromic material $WO_3.H_2O$ exhibits a layered orthorhombic structure with Pnmb space group (Fig. 1). Hence, lithium ions can easily intercalate between the tungsten trioxide sheets: the exact formula of the compound is Li_x $WO_3.H_2O$. The electron compensating Li^+ charge in Li_x $WO_3.H_2O$ resides on W. Here we report the study of the electronic transport properties of $Li_xWO_3.H_2O$ with respect lithium content x. The study of electrical transport properties becomes complicated since $Li_xWO_3.H_2O$ can only be made in powder form. So, the conductivity measurements by usual dc-techniques cannot give any information on the electrical properties owing to the complexity of the microstructure in this type of compound. Dielectric and conductivity spectra were performed within the frequency range 10 Hz to 10 GHz, using two network analysers. The measurements were made between 200 and 300 K under dry N_2 flux for x=0, 0.05, 0.15 and 0.25. Strong frequency dependence of the permittivity and the conductivity was observed in the polycrystalline samples of $Li_xWO_3.H_2O$ (Fig 2), which consist of conducting grains separated by quasi-insulating grain-boundary layers. The grains are polarised by accumulation of electrons on their boundaries, under the action of an electric field. This phenomenon exhibits dielectric relaxation as evident from the Cole-Cole plots. The relaxation frequency ν_g lies in the range 20 kHz to 100 MHz. Below ν_g, the complex resistivity plots allowed the determination of the bulk dc-conductivity of the samples with respect to the lithium content and the temperature. We observe that the dc-conductivity increases with x. For frequencies above 100 MHz, a dielectric relaxation due to water molecules oscillations was observed for lithium content x < 0.1. However, this relaxation is masked by the electronic contribution for higher lithium intercalation rate.

References:
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[2] J.C Badot, V. Bianchi, N. Baffier and N. Belhadj-Tahar, J. Phys. : Condens. Matter **14** (2002) 6917.

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* Corresponding author

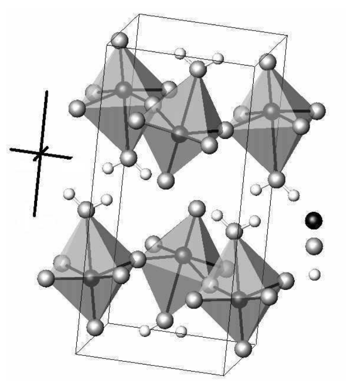

Figure 1 – Lattice structure of $WO_3.H_2O$

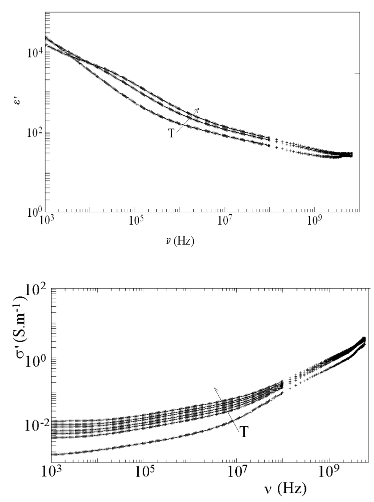

Figure 2 – Real parts of the permittivity and conductivity as functions of frequency at different temperatures for the compound $WO_3.H_2O$