Metal oxides nanofibers obtained by electrospinning

F. Martin[a], H. Soussi[a], E. Navarrete[b], E.A.. Dalchiele[c], D. Leinen, L. Martinez[c]. , J.R. Ramos-Barrado[b]

(a) Departamento de Ingeniería Química (b) Departamento de Física Aplicada I. Universidad de Málaga. Spain (c) Instituto de Física, Facultad de Ingeniería, Universidad de la República, Montevideo, Uruguay

(*) marjim@uma.es)

Nanoscale materials, such as nanowires, nanorods, nanowhiskers, and nanofibers have recently attracted attention due their exceptional properties and novel applications [1]. It has been demonstrated that metal oxide can readily be synthesized in these morphologies by electrospinning of sol-gel or polymeric solutions. Electrospinning technique is a relatively simple and versatile method for fabricating fibers with diameters ranging from tens of nanometers to micrometers. Typically in this technique, a polymer solution or melt is ejected from a small opening or a nozzle under the influence of a strong electrostatic field of negative or positive polarity. Electrostatic charges built upon the surface of the pendant drop induce the formation of a jet, which is subsequently stretched by a combination of superficial charge repulsion, superficial tension and viscosity, and finally, as the jet accelerated towards the collector, the solvent evaporated, leaving ultrathin fibers on the collector. If a metal oxide precursor is mixed o dissolved into the polymer, and the polymer is removed afterwards, for example by calcinations, it is possible to obtain metal oxide thin fibers.

The main objectives of this work were to investigate the effects of polymer and metal oxide precursor concentrations, electrostatic polarity, field strength, and calcination conditions on the morphological appearance and crystal structure of the resulting fibers. Also was an objective to apply the obtained fibers to functional devices, in our case they were used as anode materials for lithium batteries. But these ceramic fibers have other potential applications as membranes or catalysts. As example, rutile fibers were obtained by electrospinning of a mixture of titanium isopropoxide and a high molecular weight polyvinylpyrrolidone (PVP) at 20 kV with negative polarity. The PVP was removed by calcination in air at 600ºC during two hours. If the fibbers are calcined at 400ºC, then anatase structure could be obtained. If a salt of lithium is added to the initial polymeric solution, then $Li_4Ti_5O_{12}$ with a spinel structure can be obtained [2,3] when the fibbers are calcined in air at 800 ºC. $Li_4Ti_5O_{12}$ has been studied as a candidate for negative active electrodes [4] for rechargeable lithium-ion batteries. The spinel $Li_4Ti_5O_{12}$ is extremely tolerant to cycling because the volume of the cubic unit cell changes less than 1%

Figure 1, shows a SEM image of nanofibers as-spun. The figure 2 shows a distribution of rutile fiber diameters which range is between few to hundreds nanometers.

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References:

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Figures:

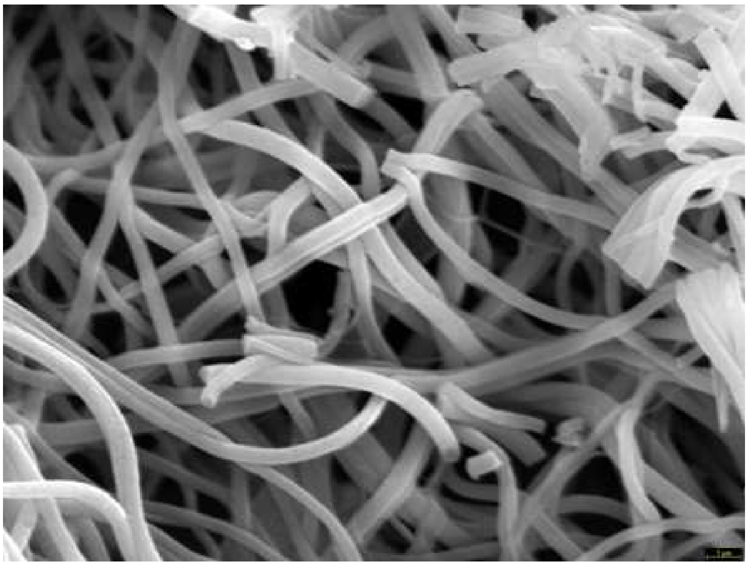

Figure 1: PVP nanofibers as spun

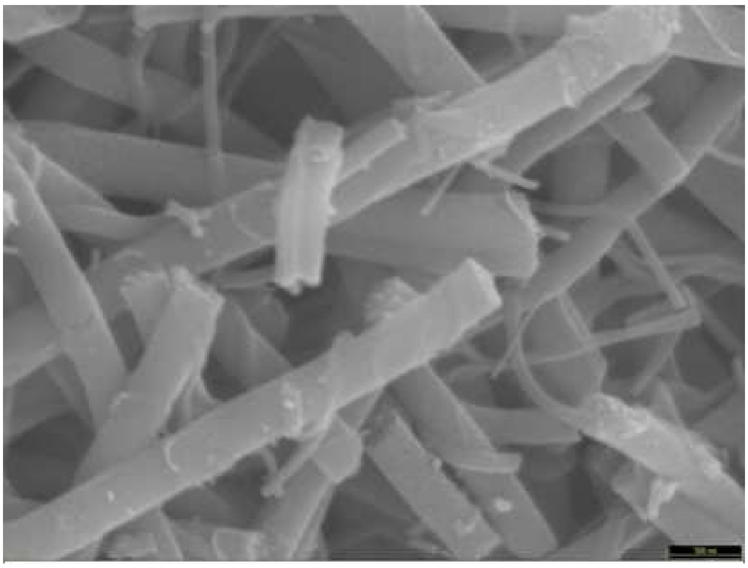

Figure 2: Rutile fibers with different diameters