Composite of silver nanoparticles in glass nanofibers produced by Laser Spinning.

Belén Cabal\textsuperscript{a}, Félix Quintero\textsuperscript{b}, Luís Antonio Díaz\textsuperscript{a}, Fernando Rojo\textsuperscript{c}, Oliver Dieste\textsuperscript{b}, Juan Pou\textsuperscript{b}, Ramón Torrecillas\textsuperscript{a} and José Serafín Moya\textsuperscript{d}

\textsuperscript{a} Nanomaterials and Nanotechnology Research Center (CINN-CSIC-UO-PA), Parque Tecnológico de Asturias, Llanera, 33428, Spain. Phone: (+34)985 733 644. e-mail: b.cabal@cinn.es.

\textsuperscript{b} Department of Applied Physics, University of Vigo, 36310, Vigo, Spain. Phone: (+34) 986 812 216. e-mail: fquintero@uvigo.es

\textsuperscript{c} National Center of Biotechnology (CNB-CSIC), Cantoblanco, 28049, Madrid, Spain. Phone: (+34) 915 854 539. e-mail: frojo@cnb.csic.es

\textsuperscript{d} Institute of Materials Science of Madrid (ICMM-CSIC), Cantoblanco, 28049, Madrid, Spain. Phone: (+34) 913 349 000. e-mail: jsmoya@icmm.csic.es

The production of organic and inorganic nanofibers with metal nanoparticles have raised great interest due to their potential applications in catalysis, environmental science and energy and biomedical technology [1-3]. Specifically, silver nanoparticles yielded very attractive results for catalysis and antibacterial applications. The advantages, in terms of higher thermal, mechanical and chemical resistance, of ceramics over polymers, motivated several works on the production of new nanocomposites of silica nanofibers containing silver nanoparticles. All these works rely on electrospinning combined with different routes for the addition of metal nanoparticles to the fibres [4-7].

In this work we present a new approach to produce a nanocomposite made of non-woven silicate glass fibers containing silver nanoparticles. The process first involves the synthesis of pellets of a soda-lime silicate glass containing silver nanoparticles with varying concentration (5 and 10 wt.%). These pellets were used as a precursor for the production of the glass fibers using the laser spining technique. In this technique, a high power laser is employed to melt a small volume of the precursor material up to high temperatures. At the same time, a supersonic gas jet was injected towards the irradiated volume by an off-axis de Laval nozzle. The high speed gas jet is responsible of the extremely quick elongation and cooling of this small volume of the viscous molten material. Thus high form factor fibers are formed. Also, the high cooling rate produces amorphous nanofibers. These fibers exhibited diameters ranging from tens of nanometers up to several micrometers (see Figure 1) and silver nanoparticles are uniformly distributed through their whole volume (Figure 2).

One of the most outstanding results of this new approach is that the metallic nanoparticles were not significantly agglomerated, the average particles size is still lower than 50 nm. This is the first time that glass nanofibers containing silver nanoparticles were obtained following a process different from electrospinning of a sol-gel [8], thus avoiding the limitations of this method and opening up a new route to
composite nanomaterials. All these novel characteristics will potentially open up a whole new range of applications.

Fig. 1 A) Macroscopic image of the glass nanofibers. B) SEM micrograph of the fibers obtained with secondary electrons at low magnifications showing their morphology. C and D) SEM micrographs obtained with backscattered electrons from fibers with different content of silver: C) fibers obtained from precursor with a silver content of 5 wt.%. D) fibers obtained from precursor with a silver content of 10 wt.%. - Reproduced by permission of The Royal Society of Chemistry (RSC) DOI: 10.1039/c3nr00638g.

Fig. 3 TEM micrographs corresponding to: A) silver glass nanofibers (5 wt.% nAg), B) and C) silver glass nanofibers (10 wt.% nAg). - Reproduced by permission of The Royal Society of Chemistry (RSC) DOI: 10.1039/c3nr00638g.

References: