Transparent electrodes based on silver nanowire networks: from fundamental aspects to integration into device

T. Sannicolo[1, 2], M. Lagrange[1], S. Xian[1], D. Muñoz-Rojas[1], C. Jimenez[1], Y. Bréchet[3], N. D. Nguyen[4], D. Bellet[1,*]

[*] *daniel.bellet@grenoble-inp.fr*

[1] *Univ. Grenoble Alpes, LMGP, F-38000 Grenoble, France*
CNRS, LMGP, F-38000 Grenoble, France

[2] *Univ. Grenoble Alpes, F-38000 Grenoble, France*
CEA, LITEN, F-38054 Grenoble, France

[3] *Univ. Grenoble Alpes, SIMAP, F-38000 Grenoble, France*
CNRS, SIMAP, F-38000 Grenoble, France

[4] *Laboratoire de Physique des Solides, Interfaces et Nanostructures*
Université de Liège, B-4000 Liège, Belgique.

The past few years have seen a considerable amount of research devoted to nanostructured transparent conducting materials which play a pivotal role in many modern devices such as: solar cells, flexible light-emitting devices, touch screens and flexible transparent thin film heaters. Metallic nanowire networks have recently been a heavily researched subject. Currently, the most commonly used material for such applications is Tin-doped Indium oxide (ITO). Although ITO exhibits very good physical properties, indium scarcity and brittleness have prompted the search for alternative materials. Among emerging transparent electrodes, silver nanowire (AgNW) networks appear as a promising substitute to ITO since these percolating networks exhibit excellent properties with sheet resistance of a few Ω/sq and optical transparency of 90%, fulfilling the requirements for many applications. It also shows very good electro-mechanical properties. In addition, the fabrication of these electrodes involves low-temperature process steps and upscaling methods, thus making them very appropriate for future use as TE for flexible devices.

Our research is focused on the fundamental understanding of the physical phenomena taking place at the scales of both the network (macroscale) and the NW-to-NW junctions (nanoscale), and on the ability of AgNW networks to be integrated as transparent electrodes for different applications. In-situ electrical measurements performed during optimisation process such as thermal annealing provide useful information regarding the activation process of the junctions. This contribution aims at presenting a short overview of the main properties and applications of metallic nanowire networks, as well as the integration in devices.

Some references of the team:

1. Flexible transparent conductive materials based on silver nanowire networks: a review, D.P. Langley, G. Giusti, C. Mayousse, C. Celle, D. Bellet, J.-P. Simonato, Nanotechnology 24 (2013) 452001

2. Highly flexible transparent film heaters based on random networks of silver nanowires, S. Sorel, D. Bellet, J.N. Coleman, ACS Nano (2014) 427–433

3. D.P. Langley, G. Giusti, M. Lagrange, R. Collins, C. Jiménez, Y. Bréchet, D. Bellet, Solar Energy Materials and Solar Cells 125 (2014) 318-324

4. D.P. Langley, M. Lagrange, G. Giusti, C. Jimenez, N.D. Nguyen, D. Bellet, Nanoscale 6 (2014) 13535

5. Optimization of silver nanowire-based transparent electrodes: effects of density, size and thermal annealing, M. Lagrange, D.P. Langley, G. Giusti, C. Jimenez, Y. Bréchet, D. Bellet; Nanoscale 7 (2015) 17410-1742