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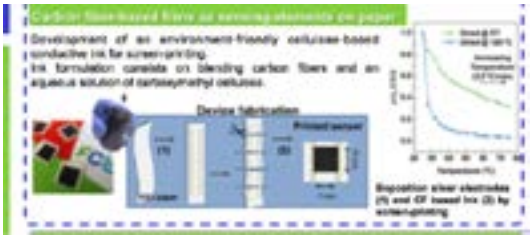
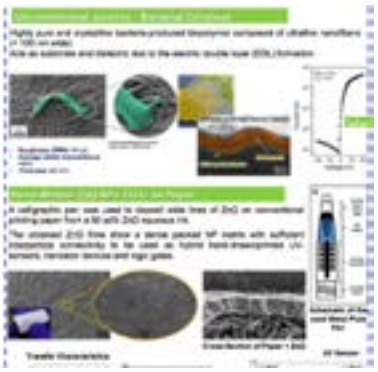
Driving flexible electronics by hybrid materials

Printable electronics and flexible electronics are the key areas of development world-wide once offer the potential to add functionality to everyday objects at very low costs that would be difficult with conventional technologies. This was pushed by the large success of organic electronics over the past few decades due to their attractive features such as low process temperatures, good mechanical flexibility, light weight and the possibility to use a wide range of substrates and being recyclable. Besides that we can prepare these devices using inexpensive solution processes over large areas. These benefits offered by printable and embedded electronics have been recognized in many sectors. Nevertheless the bottle neck here is the low electronic performances so far achieved. On the other hand, metal oxide electronic materials are quite attractive since they are reliable, able to be process at low temperature and present excellent electronic performance at 1-2D scales, providing so a large variety of different and possible applications, going from low costs to high complex systems able to compete with silicon in applications like transparent electronics, optoelectronics, magneto electronics, photonics, spintronics, thermo-electrics, piezoelectrics, power harvesting, hydrogen storage and environmental waste management. In terms of production techniques, RF magnetron sputtering has been well established and has demonstrated high performance devices, as ALD. However, these require complex equipment's, especially if we are targeting low cost applications. In contrast, the solution process has many advantages such as large-area deposition, roll-to-roll capability and easy control of composition, atmospheric processing and low cost. In parallel, we have been observing a rapid and growing interest concerning the utilization of biological materials for a wide range of applications. One of the most representative example is cellulose, not only in the form of raw material mainly for pulp and paper production, but also in the development of advanced materials/products with tailor-made properties, especially the ones based on nanostructures, for low cost and disposable applications. In this presentation, we will review the main applications of vegetal and bacterial cellulose in electronics, either as substrate (passive) or as a real electronic material (active), taking into account the expertise as well as the major developments already done at CENIMAT|i3N in the area of paper electronics.





Recent Publications

1. António T Vicente, Andreia Araújo, Manuel J Mendes, Daniela Nunes, Maria J Oliveira, Olalla Sanchez-Sobrado, Marta P Ferreira, Hugo Águas, Elvira Fortunato and Rodrigo Martins (2018) Multifunctional cellulose-paper for light harvesting and smart sensing applications. Journal of Materials Chemistry C 6(13):3143-3181.
2. I Cunha, R Barras, P Grey, D Gaspar, E Fortunato, R Martins and L Pereira (2017) Reusable cellulose based hydrogel sticker film applied as gate dielectric in paper electrolyte gated transistors. Advanced Functional Materials 27(16):1606755.
3. A Araujo, A Pimentel, M J Oliveira, M J Mendes, R Franco, E Fortunato, H Águas and R Martins (2017) Direct growth of plasmonic nano rod forests on paper substrates for low-cost flexible 3D SERS platforms. Flexible and Printed Electronics 2(1):0140016.
4. R Barras, I Cunha, D Gaspar, E Fortunato, R Martins and L Pereira (2017) Printable cellulose-based electro conductive composites for sensing elements in paper electronics. Flexible and Printed Electronics 2(1):014006.
5. A Pimentel, A Araujo, B J Coelho, D Nunes, M J Oliveira, M J Mendes, H Aguas, R Martins and E Fortunato (2017) 3D ZnO/Ag surface-enhanced Raman scattering on disposable and flexible cardboard platforms. Materials 10(12):1351.

Biography

Rodrigo Martins is a full time Professor and Head of Materials Science Department, Faculty of Science and Technology at New University of Lisbon. He is the Director of The Centre of Excellence in Microelectronics and Optoelectronics Processes of Institute of New Technologies; President of the European Academy of Science; Head of the Group of Materials for Electronics, Optoelectronics and Nanotechnologies of the Research Materials Center of the Institute for Nanostructures, Nano-modeling and Nanofabrication, CENIMAT/I3N; Chair of the European Committee Affairs of European Materials Research Society and the Global Leadership and Service Award Committee of the International Union of Materials Research Societies; Member of the Journal Management Committee for the *Journal NPJ 2D Materials and Applications*. His area of expertise is related to functional materials for electronics and energy applications. He pioneers worldwide work in the field of Transparent Electronics and is one of the Inventors of Paper Electronics.

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