ZnO nanowire based piezoelectric generators: principles, challenges and performance

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From the multitude of nanostructures under active research, Zinc Oxide (ZnO) nanowires (NWs) have attracted enormous attention due to the materials' unique electrical, optical, mechanical and piezoelectric properties. Since 12 years, piezoelectric nanogenerators (NGs) incorporating ZnO nanowires have shown great potential for their applications in mechanical energy harvesters and self-powered tactile sensors[1-3].

NGs convert a physical pressure into the motion of electrons, and thus, the unused mechanical energy of our surroundings into electrical energy, in order to supply low consumption devices. The targeted applications are diverse: health monitoring, medical implants, smart clothes, autonomous sensors, etc. Supplying them thanks to renewable energy systems, such as a photovoltaic cells, thermoelectric devices, or electromechanical harvesters, has become a major challenge for electronic industry[4].

A possible route to reduce the price of ZnO NW based NGs is using low cost manufacturing over large-area substrates, and hydrothermal synthesis appears as a promising solution.

After a general overview on GREMAN laboratory activities[5], this presentation will show the works carried out on NGs modeling, manufacturing and characterization[6], thanks to CERTeM[7] technical platform. In particular, the key issues will be presented, from the materials choice to the design and manufacturing of the full device, including the dedicated electronics, that is usually interfacing the NG and the targeted electrical load. The ongoing works will be described, as well as the perspectives of improvement of the NGs efficiency.

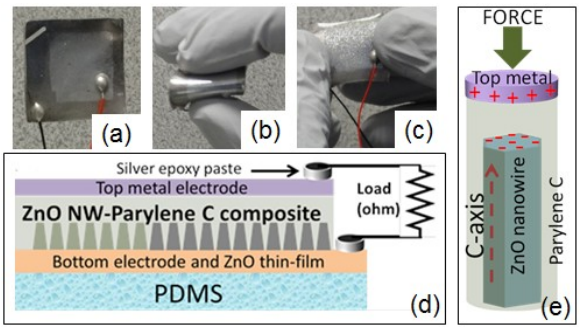

Figure 1: Optical image of the piezoelectric nanogenerator (a) free-standing, (b) folded, (c) stretched; Schematic of the (d) device structure and (e) charge generation mechanism.

References

[1] Antonino Proto, Marek Penhaker, Silvia Conforto, Maurizio Schmid, Nanogenerators for Human Body Energy Harvesting, Trends in Biotechnology, Vol.35, No.7 (July2017)

[2] Zhengbao Yang, Alper Erturk, Jean Zu, On the efficiency of piezoelectric energy harvesters, Extreme Mechanics Letters 15 (2017) 26–37

[3] Sam Crossley and Sohini Kar-Narayan, Energy harvesting performance of piezoelectric ceramic and polymer nanowires, Nanotechnology 26 (2015) 344001 (9pp)

[4] EnSO project, funded within the Electronic Components and Systems For European Leadership Joint Undertaking in collab. with the European Union's H2020 Framework Programme (H2020/2014-2020) and National Authorities, under grant agreement n° 692482, http://www.enso-ecsel.eu/

[5] GREMAN (UMR 7347, CNRS University of Tours, INSA-CVL) https://greman.univ-tours.fr/

[6] FLEXIBLE project, funded by National Research Agency (ANR-14-CE08-0010-01), https://www.nanofil-flexible.fr/

[7] CERTeM microelectronics technological research and development center, https://certem.univ-tours.fr/

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