Semiconducting nanonets: Design and integration into functional devices for multiple sensing applications

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Randomly oriented semiconducting nanowire (NW) networks, also called nanonets (NN), are novel nanostructured materials which are electrically active, transparent, fault tolerant and readily functionalized [1]. We strongly believe that such highly versatile networks will offer a great potential for an easy connection from nanostructures to macroscale applications. Currently focused on silicon and zinc oxide nanonets, our research aims to develop chemical and biological sensors, notably to detect the acetone in the breath of diabetic patients (ZnO) and DNA markers in the blood of cancer ones (SiNN).

Several important achievements will be presented. Firstly, both SiNN and ZnO-NN are homogeneously and reproducibly assembled using simple, versatile, and low-cost technique. This makes possible to transfer these networks onto any desired substrate (transparent or opaque, flexible or rigid ...), therefore allows us to apply for several large-scale applications. Secondly, the passivation step, which strongly enhances the electrical conductivity of NN and stabilizes them in air for several years, will be reported. Finally, the most important breakthrough is the successful integration of these nanonets into highly performant field-effect transistors (FETs) via standard microelectronic technology [2]. This process is quite compatible with CMOS integration that motivates us to extend our research from lab-level to industrial fabrication. The devices obtained, as shown in figure 1, have good electrical characteristics, even when the channel length is much longer than NW one. To the best of our knowledge, it is the first time that such functional nanonet devices have been reached. Their primary electrical responses to acetone and DNA hybridization will be also discussed [3].

[1] Ternon C. *et al.*, Phys Status Solidi – Rapid Res Lett. 7(10) (2013), 919-923.
[2] Legallais M *et al.*, Solid-State Electronics, 143, (2018), 97-102.
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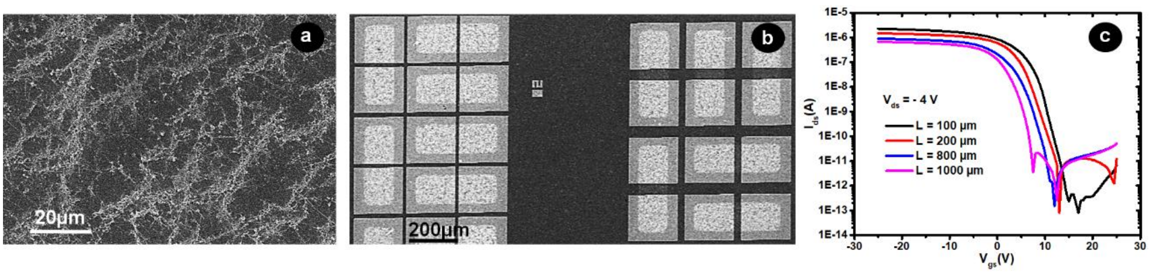

Figure 1 : (a) SEM image of assembled SiNN; (b) SEM image of SiNN-FET devices; (c) Transfer characteristics of NNFETs with channel length (L) from 100µm to 1000µm which clearly show the great conduction of NN through numerous NW/NW junctions (NW length = 7 µm).