Nanofiber Yarn-Based Flexible Gas Sensor Platform

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We report a single-strand yarn-based flexible sensor platform, which consists of core (thread)-shell (ultra-high density electrospun nanofibers) scaffold (Figure 1). The microstructure of the yarn scaffold induces facile gas accessibility for active chemical reactions. Depends on the functionalization strategies of yarn, various modes of sensors can be prepared: (i) deposition of metal or metal oxide leads to chemiresistive-type sensors and (ii) loading colorimetric dyes leads to colorimetric-type sensors. Pd-sputter deposited nanofiber yarns exhibited ultra-sensitive and selective H_2 sensing performances [1]. Based on the core (yarn)-shell (Pd layer) scaffold, *i.e.*, Pd sensing layers coated on underlying flexible nanofiber substrate, cycling reliability and flexibility were achieved. Further decoration with an ultra-thin (< 5 nm) Pt layer accelerates sensing speed. Meanwhile, though highly promising as gas sensors, oxide semiconductors critically suffer from poor surface activity, *i.e.*, low response/selectivity and sluggish reaction kinetics, especially at room temperature operation [2]. Surface coating of the sensing material with a nanoporous passivation layer can serve as a nanofiltration membrane for the selective transport of gas analytes leading to selective sensing behaviour. In this regard, we systematically designed a composite sensor platform fabricated by sputter-depositing indium tin oxide onto yarns, then additionally coating with ZIF-8 to demonstrate remarkable sensing performances at room temperature operation. We also developed an inexpensive and simple route for the mass-production of a colorimetric sensor platform with superior selectivity and sensitivity by using a composite nanofiber yarn [3]. The yarn is chemically functionalized with additives (ionic liquids, metal organic frameworks) as effective absorbents of target gas analytes and size-controlled lead-based dyes (lead acetate and lead iodide) as colorimetric indicators to detect a trace amount (ppm-level) of hydrogen sulfide and ammonia gas analytes.

Altogether, because the aforementioned strategies could be widely extended to other systems by simply utilizing various combinations of active materials, *e.g.*, metal, oxides, dyes, *etc.*, the yarn-based sensor platform possess an extraordinary potential towards the development of high-performance flexible sensors to detect toxic analytes and breath biomarkers.

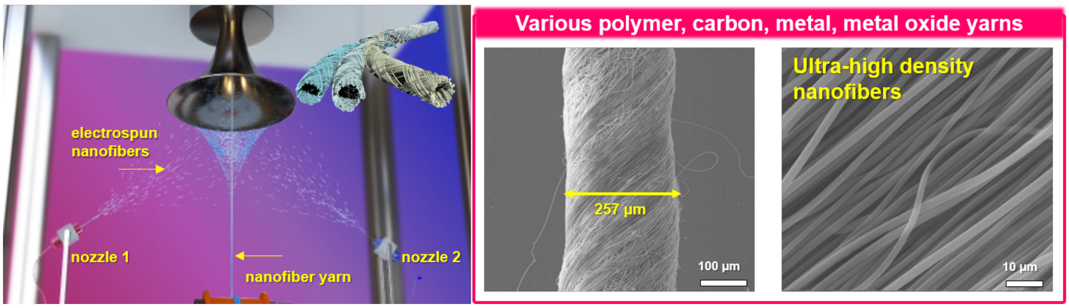

Fig. 1. Schematic illustrations of the synthesis of nanofiber yarn and SEM images of nanofiber yarn.

[1] D.-H. Kim *et al.*, ACS Nano **13**, 6071 (2019).
[2] W.-T. Koo *et al.*, ACS Nano **11**, 9276 (2017).
[3] D.-H. Kim *et al.*, ACS Nano **14**, 16907 (2020).