Non-enzymatic electrochemical sensor technology based on vertically aligned 3-D nanowire array platform

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Nanoscale devices based on nanowires have been realized for many applications in electronics, optics, gas, and biomedical sensing. Nanowire based material provide very high electrochemically active surface area, thereby leading to high detection sensitivity. Until now, noble metal nanomaterials, such as Pt, Au, Ag and their alloys [1, 2], have been extensively investigated as anodic materials for designing non-enzymatic sensor surface. Vertically aligned structures such as free standing nanowire arrays are particularly compelling for electronic interconnects, sensing and bio-sensing applications due to their suitability for high-density integration and high sensitivity to surface interactions. Although nanowires have been fabricated by various methods, a simple fabrication technique, which can maintain reasonable costs for practical applications, is highly desired. We have recently fabricated vertically aligned nanowire array using template based method and applied them to detect various analytes within various sample matrix both in environmental and health area. Major benefits on using 3D nanowire array platforms are (i) higher signal to noise ratio, (ii) high surface density, (iii) good biomolecule or biomaterial surface adhesion due to the nano structured platform, and (iv) higher catalytic activity. We have developed and demonstrated 3D sensor and biosensor platform to detect H_2O_2, glutamate and glucose. These platforms are highly sensitive and based on cheap and earth abundant materials.

Table 1. 3D Nanowire Array based sensors fabricated by Nano-Interconnection Team, Tyndall National Institute [3-6].

Electrode platform	Analyte	Sensitivity ($\mu AmM^{-1}cm^{-2}$)	Limit of detection (μM)	State of the art
AuNAE/PtNP	H_2O_2	194.60	1	Sensitivity for similar system 0.134 to 140 $\mu AmM^{-1}cm^{-2}$
NiNAE	Glutamate	96	83	This is the first of its kind enzyme free glutamate sensor with superior sensitivity
AuNAE/PdNP	H_2O_2	530	5	Sensitivity for similar system 0.134 to 140 $\mu AmM^{-1}cm^{-2}$
Ni@NiONAE	Glucose	426	14	Sensitivity for similar system 0.040 to 0.42 $mAmMcm^{-2}$

Abbreviations:

AuNAE/PtNP: Platinum nanoparticle modified 3D gold nanowire array electrode

NiNAE: 3D nickel nanowire array electrode

AuNAE/PdNP: Palladium nanoparticle modified 3D gold nanowire array electrode

Ni@NiONAE: Nickel oxide coated 3D nickel nanowire array electrode.

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