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Research Paper

Efficient fabrication of poly(pyrrole)-nanowires through innovative nanocontact printing, using commercial CD as mold, on flexible thermoplastics substrates: Application for cytokines immunodetection

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ABSTRACT

Poly(pyrrole)-nanowires (PPy-NWs) were efficiently printed by using nano printing on flexible thermoplastics, and then used to device an impedimetric immunosensor. The present pioneering technology allow to create high sensitive and disponsable immunosensor devised using a low cost and simple fabrication. The innovative nanocontact printing uses a PDMS stamp replicated from a CD mold. The PPyNW printing uses controlled chemical polymerization to print PPy-NWs on poly (ethylene terephthalate) and polyether ether ketone surfaces. Atomic force microscopy analysis of PPyNW revealed a width, height and a separation length of 125 ± 8 nm, 377 ± 5 nm and 172 ± 4 nm, respectively. The PPy-NWs were characterized by scanning electron microscopy (SEM), X-ray photoelectron spectroscopy (XPS) and electrochemical impedance spectroscopy (EIS). The XPS results evidenced the covalent bonding between the thermoplastic surface and the PPyNWs. As a final point, the immunosensor was tested for the quantification of Interleukin 6 recombinant human (IL6, Ag) using EIS. The PPy-NWs were functionalized via diazonium coupling reaction and carbodiimide crosslinker chemistry for the immobilization of Anti-human IL-6 monoclonal antibodies (IL6 mAb's). The developed immunosensor exhibited a sensitivity of 0.013 $(pg/mL)^{-1}$ (linear fitting at $R^2 = 0.99$) and limit of detection (LOD) of 0.36 pg/mL in a linear range of 1–50 pg/mL for Ag IL-6, with a relative standard deviation percentage (RSD%) at 7.6%.

1. Introduction

The new field of nanomedicine integrates nanowire (NW) arrays for the development of novel platforms for various applications such as biosensing [1]. In the recent years, the increasing demand for biosensors has been reported. There is certainly a need to improve their performance and to reduce costs. Nanoscale materials provide an alternative solution, such as NWs that have gained tremendous interest because of their interesting electrical and optical properties and quantum confinement effect, when applied to sensing applications [2]. Also, NWs are very attractive for their integration as a sensing element [3], due to their higher surface area-to-volume ratio. These nanostructures increase sensor sensitivity, offers label-free, direct, and real-time detection at very low concentrations. Devices based on NWs have emerged as one of the most powerful and general platforms for the ultrasensitive direct detection of biological and chemical species, including low concentrations of proteins and viruses [4].

Electrochemical biosensors based on submicron patterned surfaces are of great importance in many fields, especially in medicine for label free detection [5], health care [6], food industry, agriculture, and environmental control [7]. Specially, nanostructured conducting polymers (CPs) are excellent sensing platforms in the design of bio analytical sensors because of their electronic conduc-

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