

Enhanced sensing of dengue virus DNA detection using O₂ plasma treated-silicon nanowire based electrical biosensor

ABSTRACT

Dengue Virus (DENV) has become one of the most serious arthropod-borne viral diseases, causing death globally. The existing methods for DENV detection suffer from the late stage treatment due to antibodies-based detection which is feasible only after five days following the onset of the illness. Here, we demonstrated the highly effective molecular electronic based detection utilizing silicon nanowire (SiNW) integrated with standard complementary metal-oxide-semiconductor (CMOS) process as a sensing device for detecting deoxyribonucleic acid (DNA) related to DENV in an early stage diagnosis. To transform the fabricated devices as a functional sensing element, three-step procedure consist of SiNW surface modification, DNA immobilization and DNA hybridization were employed. The detection principle works by detecting the changes in current of SiNW which bridge the source and drain terminal to sense the immobilization of probe DNA and their hybridization with target DNA. The oxygen (O₂) plasma was proposed as an effective strategy for increasing the binding amounts of target DNA by modified the SiNW surface. It was found that the detection limit of the optimized O₂ plasma treated-SiNW device could be reduced to 1.985×10^{-14} M with a linear detection range of the sequence-specific DNA from 1.0×10^{-9} M to 1.0×10^{-13} M. In addition, the developed biosensor device was able to discriminate between complementary, single mismatch and non-complementary DNA sequences. This highly sensitive assay was then applied to the detection of reverse transcription-polymerase chain reaction (RT-PCR) product of DENV-DNA, making it as a potential method for disease diagnosis through electrical biosensor.

Keyword: Silicon nanowire; Dengue diagnosis; DNA hybridization detection; Plasma surface treatment; Electrical detection