World Academy of Science, Engineering and Technology
International Journal of Biotechnology and Bioengineering
Vol:12, No:08, 2018

Nanorods Based Dielectrophoresis for Protein Concentration and Immunoassay

Authors : Zhen Cao, Yu Zhu, Junxue Fu

Abstract : Immunoassay, i.e., antigen-antibody reaction, is crucial for disease diagnostics. To achieve the adequate signal of the antigen protein detection, a large amount of sample and long incubation time is needed. However, the amount of protein is usually small at the early stage, which makes it difficult to detect. Unlike cells and DNAs, no valid chemical method exists for protein amplification. Thus, an alternative way to improve the signal is through particle manipulation techniques to concentrate proteins, among which dielectrophoresis (DEP) is an effective one. DEP is a technique that concentrates particles to the designated region through a force created by the gradient in a non-uniform electric field. Since DEP force is proportional to the cube of particle size and square of electric field gradient, it is relatively easy to capture larger particles such as cells. For smaller ones like proteins, a super high gradient is then required. In this work, three-dimensional Ag/SiO2 nanorods arrays, fabricated by an easy physical vapor deposition technique called as oblique angle deposition, have been integrated with a DEP device and created the field gradient as high as of 2.6×10^{24} V^2/m^3. The nanorods based DEP device is able to enrich bovine serum albumin (BSA) protein by 1800-fold and the rate has reached 180-fold/s when only applying 5 V electric potential. Based on the above nanorods integrated DEP platform, an immunoassay of mouse immunoglobulin G (IgG) proteins has been performed. Briefly, specific antibodies are immobilized onto nanorods, then IgG proteins are concentrated and captured, and finally, the signal from fluorescence-labelled antibodies are detected. The limit of detection (LoD) is measured as 275.3 fg/mL (~1.8 fM), which is a 20,000-fold enhancement compared with identical assays performed on blank glass plates. Further, prostate-specific antigen (PSA), which is a cancer biomarker for diagnosis of prostate cancer after radical prostatectomy, is also quantified with a LoD as low as 2.6 pg/mL. The time to signal saturation has been significantly reduced to one minute. In summary, together with an easy nanorod fabrication and integration method, this nanorods based DEP platform has demonstrated highly sensitive immunoassay performance and thus poses great potentials in applications for early point-of-care diagnostics.

Keywords : dielectrophoresis, immunoassay, oblique angle deposition, protein concentration
Conference Title : ICNB 2018 : International Conference on Nanotechnology and Biosensors
Conference Location : Venice, Italy
Conference Dates : August 13-14, 2018