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Communication

Anisotropic CdSe Tetrapods in Vortex Flow for Removing Non-Specific Binding and Increasing Protein Capture

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Abstract: Non-specific binding (NSB) is one of the important issues in biosensing performance. Herein, we designed a strategy for removing non-specific binding including anti-mouse IgG antibody and bovine serum albumin (BSA) by utilizing anisotropic cadmium selenide tetrapods (CdSe TPs) in a vortex flow. The shear force on the tetrapod nanoparticles was increased by controlling the rotation rate of the vortex flow from 0 rpm to 1000 rpm. As a result, photoluminescence (PL) signals of fluorescein (FITC)-conjugated protein, anti-mouse IgG antibody-FITC and bovine serum albumin (BSA)-FITC, were reduced by 35% and 45%, respectively, indicating that NSB can be removed under vortex flow. In particular, simultaneous NSB removal and protein capture can be achieved even with mixture solutions of target antibodies and anti-mouse IgG antibodies by applying cyclic mode vortex flow on anisotropic CdSe TPs. These results demonstrate successfully that NSB can be diminished by rotating CdSe TPs to generate shear force under vortex flow. This study opens up new research protocols for utilization of anisotropic nanoparticles under vortex flow, which increases the feasibility of protein capture and non-specific proteins removal for biosensors.

Keywords: anisotropic nanoparticles; CdSe tetrapods; protein capture; non-specific binding removal; cyclic mode vortex flow

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1. Introduction

The application of protein capture has attracted considerable interest in disease diagnosis, and studies have focused on improving sensitivity and selectivity of the biosensors [1–3]. Various technologies, such as surface plasmon resonance and enzyme-linked immunosorbent assays [4–9], have been applied to the field of protein capture. The technologies generated specific signals for target analyte via interaction between probe and target proteins. To further increase sensitivities of these biosensors, non-specific binding of proteins should be avoided. Non-specific proteins induced by the physical, chemical, or electrostatic adsorption [10,11] can result in a false signal, a decrease in the signal-to-noise ratio, and a reduction in the sensitivity and selectivity of protein capture.

Separation techniques, including desalting and filtration, can be employed to reduce non-specific binding (NSB) of proteins [12–14]. Another way to overcome non-specific adsorption is by utilizing buffer solutions, such as Tween-20 and sodium dodecyl sulfate. This approach creates a hydrophilic and noncharged interface layer to reduce protein adsorption [15–21]. In addition, microfluidic devices have also been applied to remove non-specific protein adsorption by manipulating surface shear forces and fluid mixing. The shear force occurs due to the friction between the nanoparticle and the aqueous fluid flow. It enables the preferential selection of strongly bound specific proteins and thus enhances target signals [22–25]. Most microfluidic devices for protein capture have focused on the nanoparticles at the constant flow rate. However, little attention has been paid to utilization of the morphological design of nanoparticles under flow field for improving protein capture.