Fabricating a Novel Ultrasensitive Flexible Biosensor with Patterned 10 nm Single Antibody Size Periodic Line Channel Created by Directed Molecular Self-Assembly to Achieve Extremely High Accuracy in the Earlier Detection of Cancer

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A novel flexible MoS2-based biosensor with patterned 10 nm single antibody size periodic line channel has been fabricated for the first time. In order to confine singular biomolecule movement within the narrow channels for high accuracy measurement and also to improve the sensitivity of the biosensor through the antibody-antigen binding, the MoS2 channel layer was patterned into 10 nm periodic nano-lines using directed molecular self-assembly and plasma etching. The electron beam lithography technique was used to define the sensor channel width by creating a organic resist pattern on the top of patterned MoS2 layer. This process was followed by an gold metal thin film evaporation and lift-off process to form the channel and gold electrode nanostructures. The patterned MoS2 biosensor, with a channel width of ~100 nm, was successfully fabricated onto a flexible polyimide substrate. Using this patterned channel biosensor and two different biomolecules, streptavidin and interleukin-1beta, with lower concentration of 10 fM, each have been tested. The flexible MoS2 biosensors exhibited an Interleukin 1-beta (IL-1ß) detection limit as low as 50 fM, about 10000 times lower concentration than what can be detected by the conventional enzyme-linked immunosorbent assay method. The flexible MoS2 biosensor with 10 nm line channel can be utilized for quantifying the time-dependent reaction kinetics of streptavidin-biotin binding. This is the first time to demonstrate the fabrication of flexible MoS2 biosensors with patterned 10 nm single antibody size line channel capable of detecting low-abundant biomarker at femtomolar level. This fabricated biosensor is capable of detecting at the 10 fM level biomolecules and therefore increases the accuracy of this biosensor to roughly 96%.

Awards Won:

American Chemical Society: Fourth Award of $1,000