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High-Speed Lateral Flow Strategy for a Fast Biosensing with an Improved Selectivity and Binding Affinity

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Abstract: We report a high-speed lateral flow strategy for a fast biosensing with an improved selectivity and binding affinity even under harsh conditions. In this strategy, biosensors were fixed at a location away from the center of a round shape disk, and the disk was rotated to create the lateral flow of a target solution on the biosensors during the sensing measurements. Experimental results using the strategy showed high reaction speeds, high binding affinity, and low nonspecific adsorptions of target molecules to biosensors. Furthermore, binding affinity between target molecules and sensing molecules was enhanced even in harsh conditions such as low pH and low ionic strength conditions. These results show that the strategy can improve the performance of conventional biosensors by generating high-speed lateral flows on a biosensor surface. Therefore, our strategy can be utilized as a simple but powerful tool for versatile bio and medical applications.

Keywords: lateral flow; rotating disk; reaction speed; binding affinity; selectivity

1. Introduction

The delivery of target molecules by liquid flows has been often utilized in various biosensing systems. For example, a rapid kit based on a lateral flow assay used a sample flow driven by the capillary force of a liquid sample [1]. In the kit, a liquid sample containing the analyte of interest was loaded onto one end of the kit, and the sample flowed through various zones of receptor-coated strips. As another example, in a lab-on-chip system, the analyte solutions flow through micro channels, which conduct a series of reaction processes, including the pretreatment of samples and the binding reaction between the targets and their receptors [2]. In these examples, the lateral flow of the analyte solutions is mostly used for the delivery of the analyte solution to the desired location of the sensor.

Meanwhile, the performances of biosensing systems, including the examples above, are often limited by several factors. For example, the diffusivity of the target molecules could affect the detection limit and speed of a biosensor [3]. Moreover, the non-specific binding of molecules could lead to a decrease in the sensitivity of biosensors by increasing the background noise of sensor signals [4]. These factors could result in fundamental limitations on conventional biosensing systems. Thus, various techniques have been suggested to overcome the fundamental limitations of biosensing systems. For example, motion-based approaches using microstructures such as magnetic particles and micromotors have been used to enhance the detection speeds of biosensors, where target