Ultra High-sensitive Biochips Based on Magnetic Method

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Nanomagnetics are opening a new era not only in industrial applications especially related with information science and technology, but also in bioassays related to biomolecule translocation, biochip/sensors and multiplex bio-recognition channels. Ever since giant magnetoresistance (GMR) has been applied to a biochip sensor for recognition of biomolecule tags of magnetic particle in 1996, many researches have been carried out to enhance the resolution of the magnetic particle tags, corresponding to that of hybridized biomolecule pairs. At present, several groups in the worldwide have succeeded to enhance the sensor resolution down to a few pairs of probe-target biomolecules.

Firstly, I would like to focus on the overview and current status of magnetic bioassays. Secondly, I will introduce a novel system for translocation of magnetic beads at specific sites of the sensor surface on a single chip for biosensing applications. The soft NiFe elliptical (9 μm×4 μm×0.1 μm) elements are arranged as magnetic pathways. The patterned NiFe elliptical pathways can generate different stray magnetic fields when they are subjected to the external rotating magnetic field. The in-homogeneity in stray magnetic fields can govern the magnetic bead/nanwire motion on the pathways. We demonstrate the motion of Dynabead® M-280 magnetic bead and magnetic nanowire on patterned pathways by controlling the external rotating magnetic field in clockwise and counter clockwise directions. The magnetic beads/nanowires were placed on the magnetic elliptical pathways are shown to be transported to specific location on the surfaces. This technique enables micro-translocation of the magnetic beads/nanowires coated with biomolecules to the specific binding sites of the sensor surface and as well as drive off the non-specific binding biomolecules from the surface in performing number of sequential bead/nanowire detection using magnetic sensor experiments for future integrated lab-on-a chip systems.

Thirdly, I would like to introduce the planar Hall Resistance (PHR) effect in magnetic multilayers structures and fabrication of high sensitive PHR biosensor for biomedical diagnosis. In this context, we optimized the performance of PHR spin valve sensor for the single micro-bead of size 2.8 μm (Dynabeads® M-280) detection. The single PHE sensor exhibits a sensitivity of about 7.2 μV/(Oe.mA) in the magnetic field range of ±7 Oe approximately. And also we obtained the maximum signal change of $\Delta V \sim 1.1$ μV at the field ~ 6.6 Oe. Finally, I will show some results on biomolecule manipulation, i.e., DNA immobilization, removal of non-specific hybridization using magnetic method.

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