

Giant Magnetoresistive Sensors for Chip-Scale Biorecognition: Towards Chip-Scale Platforms with Ultrahigh Address Densities

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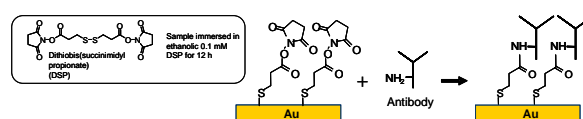
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We describe the fabrication, optimization, and deployment of giant magnetoresistors (GMR) for the detection of magnetically labeled molecules of biological importance (bioanalytes). Giant magnetoresistors are several nanometers thick, microfabricated structures, originally developed as readout elements for computer magnetic memory devices, i.e., hard-drives. The GMR response is manifested as a change in resistance as a function of change in external magnetic field. We exploit this phenomenon to detect nanometric magnetic labels bound to address-specific bioanalytes. (Figure 1) This strategy results in a detection platform of high sensitivity, small size, fast overall analysis times, and relative ease of multiplexing – figures of merit that are desirable for portable bioanalytical sensors. In this paper we describe GMR fabrication, magnetic labeling methodologies, surface derivatization approaches based on protein-protein binding, and transduction optimization, all of which are aimed at forming a general set of protocols to move GMR concepts into the bioanalytical arena.

Our approach relies on the development of a “card-swipe” instrument in which an array of chip-scale addresses captures specific analytes during sample presentation. The captured analytes are then magnetically tagged and interrogated in a manner analogous to a credit card reader. The GMR response is internally calibrated with an on-chip magnetic reference. (Figures 2, 3, and 4) This integrated, internal reference shows great potential in simplifying quantitative analysis by the GMR sensor.

The efficacy of this method is demonstrated by the enumeration of fewer than 100 molecular binding events realized with a protein-protein capture strategy on this first iteration detection platform.

Preparation of Antigen Capture Substrate



Sandwich Immunoassay

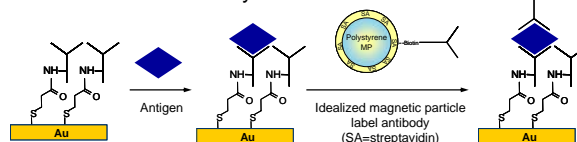


Figure 1 Idealized schematic depicting derivatization of capture surface, sample recognition, and magnetic labeling strategy.

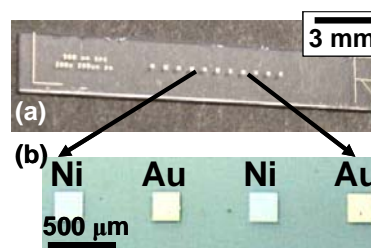


Figure 2 Photograph showing capture (Au) and reference (Ni) addresses of sample stick

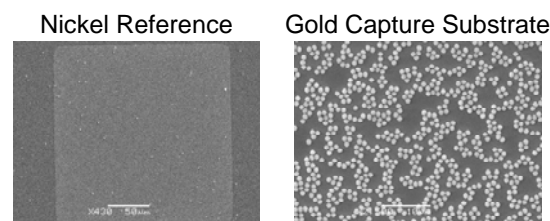


Figure 3 Scanning electron micrograph showing reference and magnetic particle capture addresses. Scale bar is 50 μm for Ni and 10 μm for Au image.

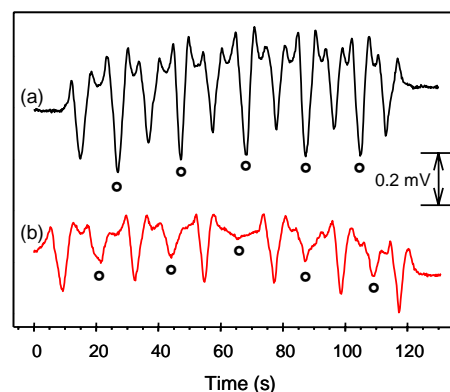


Figure 4 (a) GMR response to a sample stick incubated with 200 ng/mL rabbit IgG (where Au address signal is denoted with ○), and (b) response scan from sample stick incubated with 50 ng/mL rabbit IgG.

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