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We present an overview of the development of sensors based on anisotropic magnetoresistance in exchange-biased thin films in particular sensor geometries termed planar Hall effect bridges (PHEBs) [1]. The basic bridge building blocks can be combined to form sensors that are sensitive to: (1) an external magnetic field and/or (2) the small magnetic field from magnetic beads magnetized by the field induced by the sensor bias current (Fig. 1a-b,d-e) [2]. The latter detection scheme can be used for biosensing in two formats: (1) a volume-based detection scheme, where the changes in dynamic magnetic rotation response of magnetic beads are measured in the presence of the target [2], (2) a surface-based detection scheme where the target-mediated binding of magnetic beads to localized parts of the sensor surface is monitored in real-time [3]. The use of the sensor self-field avoids the need for external electromagnets and it also eliminates the counteracting signal contributions from magnetic beads over and outside the sensor area [4]. For surface-based detection, we have demonstrated the use of a differential bridge geometry (dPHEB) for DNA detection (Fig. 1c). This geometry measures only the difference in signals between the top half functionalized with DNA probes and the un-functionalized bottom half [3]. This cancels out background and enables real-time measurements of the specific binding signal, even in the background of a magnetic bead suspension. Finally, the sensitivity of the sensor can be tuned by varying t_{FM} and t_{Cu} in the exchange-biased sensor stack, $Ni_{80}Fe_{20}(t_{FM})/Cu(t_{Cu})/Mn_{80}Ir_{20}$(10-20 nm), where higher sensitivity is obtained for larger values of t_{FM} and t_{Cu} [5]. The design of PHEB sensors is flexible and can be adapted to various applications for magnetic field sensing and magnetic biosensing as illustrated in Fig. 1.

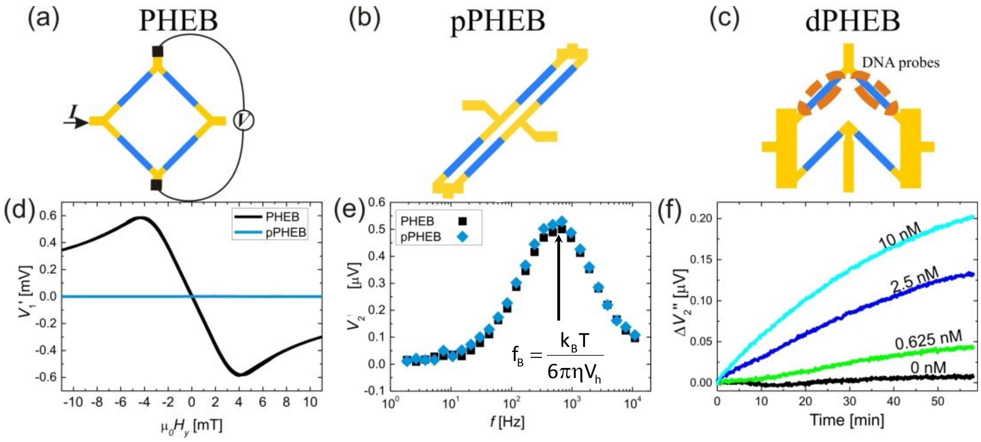

Figure 1: (a) PHEB, (b) pPHEB, and (c) dPHEB geometries. (d) Field sweeps of PHEB and pPHEB sensors. Only the PHEB sensor is sensitive to the external field [2]. (e) Measurements of Brownian relaxation of magnetic beads in suspension for PHEB and pPHEB sensors, where they give the same signal [2]. The peak frequency, f_B, is inversely proportional to the hydrodynamic volume, V_h. (f) Signal from DNA-mediated magnetic bead binding vs. incubation time for dPHEB sensor. The specific signal was measured in a background from a magnetic bead suspension [3].

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