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In recent years there has been an increasing interest in developing lab-on-a-chip devices that potentially can be used as point-of-care biosensors. The advantage of point-of-care biosensors is that they can analyze samples obtained from patients immediately, cutting away the time needed for sending the sample to a laboratory for analysis. Many different read out techniques can be used for point-of-care biosensors, among these are magnetic readouts, which are especially interesting because most biological samples are non-magnetic. The goal of this thesis is to explore the possibilities and limitations of using planar Hall effect magnetic field sensors to measure magnetorelaxometry of magnetic beads. This can be used as the readout principle for volume-based biosensing, by detecting changes in the hydrodynamic diameter of magnetic beads due to binding of analytes. Traditionally magnetorelaxometry is measured by AC susceptibility measurements performed with large expensive instruments, which cannot easily be integrated with a lab-on-a-chip system. The advantages of planar Hall effect sensors are that they are small and can easily be integrated as the readout method for a lab-on-a-chip device.

In this thesis, the theoretical background for how magnetorelaxometry is measured using planar Hall effect sensors is derived. This includes a description of the relaxation mechanism of magnetic beads in both the time and frequency domains, how the planar Hall effect sensors are utilized for measuring the relaxation of magnetic beads without the need of any external fields and estimates of the forces that influence magnetic beads near a planar Hall effect sensor. The temperature dependence of measurements using planar Hall effect sensors is investigated. This is done both with respect to how the sensor signals depend on temperature and how temperature influences the Brownian relaxation of magnetic beads. It is shown that the hydrodynamic diameter of the magnetic beads can be extracted from AC susceptibility measurements with planar Hall effect sensors when the temperature and dynamic viscosity of the liquid in which the beads are suspended are known.

AC susceptibility measurements of beads are shown to be possible using two different sensor geometries, planar Hall effect cross sensors and planar Hall effect bridge sensors. For the geometries used, the bridge sensor yields an amplification of the bead signals by a factor of six compared to the cross sensor without significant noise being added to the measurements. A study varying the concentration of magnetic beads with a nominal diameter of 40 nm shows that the hydrodynamic diameters can be extracted reliably for concentrations down to 64 _g/mL, and the presence of beads can be detected down to 16 _g/mL. However, higher bead concentration leads to higher signal and thereby hydrodynamic diameters can be extracted more reliably.

Furthermore, it is shown that the planar Hall effect can be operated at frequencies ranging from DC to 1 MHz. This wide range of frequencies allows for measuring Brownian relaxation of magnetic beads with nominal diameters ranging from 10 nm to 250 nm. However, it is not appropriate to use beads as large as 250 nm with the planar Hall effect sensors as they are captured by magnetostatic forces from the sensor stack. Experiments with streptavidin coated beads and biotin-conjugated bovine serum albumin show that planar Hall effect sensors can detect the presence of biotin-conjugated bovine serum albumin in the nanomolar range. Finally, measurements are performed to detect DNA-coils formed by rolling amplification using planar Hall effect bridge sensors. These results show that DNA-coils can be detected in concentrations down to 4 pM, which is comparable to what has been obtained for similar samples using commercially available measurement equipment. However, the planar Hall effect sensor have the advantage of being considerably smaller, much more simple and potentially cheaper.

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