Superconducting quantum interference device-based magnetic nanoparticle relaxation measurement as a novel tool for the binding specific detection of biological binding reactions (abstract)

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Biological binding reactions play a key role in biology and medicine. Their detection is usually achieved by labeling one of the reaction components with radioisotopes, enzymes, or fluorescence dyes. In particular assays, using the specificity of the reaction between antibodies and antigens are of outstanding importance. Most of these assays are hampered by the drawback that the label generates a signal that is not influenced by the binding reaction. Therefore, separation procedures between bound and unbound reaction components are mostly inevitable. Here, we present the use of superconducting quantum interference device (SQUID)-based magnetic nanoparticle relaxation measurement as a novel tool for the quantitative determination of biological binding reactions, where magnetic nanoparticles are used as labels to antibodies. The rotational diffusion of the label is hindered by the binding of the antibody to the antigen, which is adsorbed to the sample tube wall. As a result, the observed relaxation of its magnetization is driven by the internal reorientation of the magnetic moment of the nanoparticle (Néel relaxation). By this, the measured signal is specific for the magnetically labeled antibody bound to the antigen. We could show that already at a very early stage of technical development SQUID-based magnetic nanoparticle relaxation shows a higher sensitivity as a comparable standard assay technique (enzyme linked immunosorbent assay), without the need of any separation step between bound and unbound reaction components. Magnetic nanoparticle relaxation amplitudes as small as 500 fT were detectable. This corresponds to a magnetic moment of $m = 1.6 \times 10^{-10}$ A m^2 or, e.g., some 5×10^6 spherical magnetic iron oxide nanoparticles of 50 nm diameter. [S0021-8979(97)83308-7]