Novel Readout Method for Molecular Diagnostic Assays Based on Optical Measurements of Magnetic Nanobead Dynamics

We demonstrate detection of DNA coils formed from a Vibrio cholerae DNA target at picomolar concentrations using a novel optomagnetic approach exploiting the dynamic behavior and optical anisotropy of magnetic nanobead (MNB) assemblies. We establish that the complex second harmonic optical transmission spectra of MNB suspensions measured upon application of a weak uniaxial AC magnetic field correlate well with the rotation dynamics of the individual MNBs. Adding a target analyte to the solution leads to the formation of permanent MNB clusters, namely, to the suppression of the dynamic MNB behavior. We prove that the optical transmission spectra are highly sensitive to the formation of permanent MNB clusters and, thereby to the target analyte concentration. As a specific clinically relevant diagnostic case, we detect DNA coils formed via padlock probe recognition and isothermal rolling circle amplification and benchmark against a commercial equipment. The results demonstrate the fast optomagnetic readout of rolling circle products from bacterial DNA utilizing the dynamic properties of MNBs in a miniaturized and low-cost platform requiring only a transparent window in the chip.