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Protein Detection on an Optical Balance Diffraction Grating
XUEFENG WANG, DAVID NOLTE — We have developed a sensitive biosensor for protein detection called the diffraction land-contrast BioCD (DLC BioCD) in which a substrate is patterned into a diffraction grating that has vanishing first-order diffraction based on a sensitive balance of surface reflction. The graging is patterned using photolithography, and protein that is immobilized on the grating drives it off balance to generate a considerable diffraction signal. We fabricated a DLC surface based on a thermal oxide silicon wafer. Gratings consisting of grooves 65 nm deep with an 8 μm periodicity are etched into 200 nm SiO_2 on a silicon wafer. The first-order diffraction is proportional to $|r_1 - r_2|^2$ where r_1 and r_2 are the reflection coefficients on 200 nm SiO_2/Si and 135 nm SiO_2/Si. $r_1 \approx r_2$ for 488 nm wavelength light at normal incidence, and the grating generates nearly zero first-order diffraction. After applying a protein layer on the SiO_2, the complex values of r_1 and r_2 change with different signs on the complex plane. Therefore the change of $|r_1 - r_2|^2$ caused by protein is maximized while the near-zero background significantly improves the sensitivity for protein detection. Experiments show that the signal-to-noise ratio of the protein signals is improved by a factor of 4 compared to a conventional BioCD, with further improvements possible.

Xuefeng Wang

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