Label-free binding analysis of 4-(2-Pyridylazo)-resorcinol-based composite layer with cobalt ion using surface plasmon resonance optical sensor

ABSTRACT

Label-free measurements of small-molecule binding interactions are of high interest to researchers across multiple scientific disciplines. Label-free optical sensors based on surface plasmon resonance (SPR) have been widely used for detecting various targets including toxic heavy metals in solutions. In this research, an SPR optical sensor enhanced with a 4-(2-pyridylazo)-resorcinol (PAR)-based composite layer was employed for the detection of the cobalt ion (Co^{2+}). A binding analysis study was conducted by monitoring the interaction between Co^{2+} and the sensing layer thin film. In our experiment, there were no changes in SPR angle for a gold layer in contact with Co^{2+} of different concentrations, whereas the enhanced SPR sensor produced a maximum SPR angle shift of 0.328°. From the relationship between the angle shift and the concentration of Co^{2+}, the sensor had a sensitivity of 0.2375° ppm−1 for concentrations of less than 1 ppm, 0.0044° ppm−1 for concentrations of 1 to 10 ppm, and 0.00069° ppm−1 for concentrations from 10 to 100 ppm. Further analysis was also carried out by calculating the full width at half maximum (FWHM), detection accuracy (DA), and signal-to-noise ratio (SNR). In the binding analysis, the experimental results were fitted with Langmuir, Freundlich, and Sips isotherm equations. It was found that the Sips isotherm equation most closely fitted the experimental data with an R^2 value of 0.96716 and a binding affinity of 1.649 ppm−1.