

Design and optimization of surface plasmon resonance spectroscopy for optical constant characterization and potential sensing application: theoretical and experimental approaches

ABSTRACT

The best surface plasmon resonance (SPR) signal can be generated based on several factors that include the excitation wavelength, the type of metal used, and the thickness of the metal layer. In this study, the aforementioned factors have been investigated to obtain the best SPR signal. The excitation wavelength of 633 nm and gold metal with thickness of 50 nm were required to generate the SPR signal before the SPR was used for optical constant characterization by fitting of experimental results to the theoretical data. The employed strategy has good agreement with the theoretical value where the real part refractive index, n value, of the gold thin film was 0.1245 while the value for the imaginary part, k , was 3.6812 with 47.7 nm thickness. Besides that, the optical characterization of nanocrystalline cellulose (NCC)-based thin film has also been demonstrated. The n and k values found for this thin film were 1.4240 and 0.2520, respectively, with optimal thickness of 9.5 nm. Interestingly when the NCC-based thin film was exposed to copper ion solution with n value of 1.3333 and k value of 0.0060 to 0.0070 with various concentrations (0.01–10 ppm), a clear change of the refractive index value was observed. This result suggests that the NCC-based thin film has high potential for copper ion sensing using SPR with a sensitivity of $8.0052^\circ/\text{RIU}$.

Keyword: Surface plasmon resonance; Nanocrystalline cellulose; Optical characterization; Copper ion