Impact of Taguchi Optimization in Fiber Surface Plasmon Resonance Sensors Based on Si_3N_4 Layer

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Aims and scope

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N. Mudgal, Kamal Kishor Choure, Manoj Kumar Falaswal, Rahul Pandey, Ankit Agar… Saurabh Sahu & G. Singh

Abstract

This article exhibits a fiber plasmonic sensor based on a silver (Ag) layer and a silicon nitride (Si_3N_4) layer with a wide dynamic range of refractive index sensing. The Taguchi (L9) orthogonal array method is applied to optimize the design parameters such as fiber core, sensing region length, and the thickness of Ag/Si_3N_4 layers. The performance of the structure is investigated for the full-width half maxima (FWHM) as the smaller the better (STB). The smaller FWHM favors accurate detection, high-quality factor, and better sensitive detection of biomolecules. With the use of analysis of variance (ANOVA), it is evident that for the normalized transmitted power, the Ag layer thickness contributes 47.36%, while the Si_3N_4 layer thickness contributes 0.06% only. Furthermore, the length of the sensing region has the highest dominating factor effect of 53.26% whereas the thickness of the Si_3N_4 layer has the least dominating factor effect of 6.90% on FWHM. This work has shown the highest sensitivity of 6287 nm/RIU whereas the quality factor and detection accuracy are 873.19 RIU^{-1} and 87.31 respectively. Hence, Taguchi's optimization approach is suitable in multilevel optimization of different control factors that lead to the robust design of the fiber SPR sensor.