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Fiber-Optic SPR Sensor Based on MMF-SMF-MMF Structure for Detection of Compositional Variations in Diesel Fuel

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Abstract. The article presents a fiber-optic surface plasmon resonance sensor based on a multimode–single-mode–multimode fiber structure for detecting compositional variations and differentiating diesel fuel grades. The sensor design, modelling approach, and experimental implementation are described. To enhance the sensitivity and contrast of the resonant response, the central 15–17 mm section of the single-mode fiber was coated with a multilayer Al/Al_2O_3 structure. Numerical modelling was performed using the Kretschmann configuration and the transfer matrix method. Experimental measurements were conducted using 50 diesel fuel samples with different physicochemical characteristics. A monotonic dependence of the resonance wavelength on the refractive index was demonstrated, enabling differentiation between standard and arctic diesel fuel. The developed sensor exhibited an average sensitivity of 13300 nm per refractive index unit. The potential and limitations of refractive-index-based sensing for diesel fuel quality control are also discussed.

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