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| **Abstract:** |  |
| Abstract— We demonstrate a simple and straightforward photonic crystal fiber (PCF) sensor for voltage and comparatively higher refractive index (RI) sensing, incorporating the surface plasmon resonance (SPR) phenomenon for better and more reliable performance. The sensor contains three air holes; the central air hole is filled with an electric field-tunable nematic liquid crystal (NLC), while the remaining holes are filled with the analyte. Due to changes in the surrounding voltages, the RI of NLC varies, and the sensor exhibits excellent sensitivity of 6 nm/V and a resolution of 16.67 mV in the voltage range of 200 V to 250 V. The sensor also demonstrates outstanding linearity performance. Additionally, the sensor is capable of RI detection in the sensing range of 1.45 to 1.50, which is rarely reported in the literature. In RI sensing, a sensor resolution of 4.00×10–5 RIU and a sensitivity of 25,000 nm/RIU are recorded across the sensing range. Furthermore, the sensor’s performance is evaluated for different brain-injured tissues, showing excellent results in this application as well. Hence, it can be easily observed that the proposed sensor has the potential to perform well in both the power sector and the biosensing field. | |