Bio-based polycationic polyurethane as an ion-selective membrane for nitrate tapered optical fiber sensors

ABSTRACT

A novel bio-based polycationic polyurethane as an ion-selective membrane for nitrate sensing was successfully developed. In this work, the intermolecular interactions at active polymeric sites play a primary role in selective nitrate-ion detection. From the experiment, FTIR shows a significant shift from 1543 cm−1 to 1548 cm−1 in N-H bending, indicating that intermolecular interactions occur between the polycationic polyurethane and nitrate. AFM shows that the surface roughness of the polycationic polyurethane decreases from 95.7 nm to 12.2 nm after immersion in nitrate solution. Meanwhile, FESEM images show that the bright area, which represents the hard segment of polycationic polyurethane, decreases after immersion, indicating that the nitrate is interacting with the hard segment of the polycationic polyurethane via intermolecular interaction. Furthermore, EIS shows that the conductivity increases from 2.84 × 10−11 to 5.34 × 10−11 S cm−1 after ion exchange occurs between the iodide and nitrate on the polycationic polyurethane. To assess the sensing performance, the sensor probe is fabricated by coating the polycationic polyurethane thin film on the tapered region of an optical fiber. Rapid detection, good repeatability, and a sensitivity of 5.94 × 10−2μW/ppm are obtained for nitrate detection using the above bio-based-sensing material. The selectivity study also shows that the sensing material possesses high affinity toward the nitrate ion.

Keyword: Optical fiber sensor; Chemical sensor; Ion-selective membrane, Nitrate sensing; Polyurethane