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Silicon-Photonic-Sensor System for Botulinum Toxin Detection in Water

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Abstract : Silicon-photonic-sensor system is an emerging class of analytical technologies that use evanescent field wave to sensitively measure the slight difference in the surrounding environment. The wavelength shift induced by local refractive index change is used as an indicator in the system. These devices can be served as sensors for a wide variety of chemical or biomolecular detection in clinical and environmental fields. In our study, a system including a silicon-based micro-ring resonator, microfluidic channel, and optical processing is designed, fabricated for biomolecule detection. The system is demonstrated to detect Clostridium botulinum type A neurotoxin (BoNT) in different water sources. BoNT is one of the most toxic substances known and relatively easily obtained from a cultured bacteria source. The toxin is extremely lethal with LD50 of about 0.1µg/70kg intravenously, 1µg/ 70 kg by inhalation, and 70µg/kg orally. These factors make botulinum neurotoxins primary candidates as bioterrorism or biothreat agents. It is required to have a sensing system which can detect BoNT in a short time, high sensitive and automatic. For BoNT detection, silicon-based micro-ring resonator is modified with a linker for the immobilization of the anti-botulinum capture antibody. The enzymatic reaction is employed to increase the signal hence gains sensitivity. As a result, a detection limit to 30 pg/mL is achieved by our silicon-photonic sensor within a short period of 80 min. The sensor also shows high specificity versus the other type of botulinum. In the future, by designing the multifunctional waveguide array with fully automatic control system, it is simple to simultaneously detect multi-biomaterials at a low concentration within a short period. The system has a great potential to apply for online, real-time and high sensitivity for the label-free bimolecular rapid detection.

Keywords : biotoxin, photonic, ring resonator, sensor
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