Molecularly imprinted sol-gel based on LSPR sensor for selective fatty acid vapor detection

Liang Shang, Chuanjun Liu and Kenshi Hayshi
Department of Electronics, Graduate School of Information Science and Electrical Engineering, Kyushu University, Fukuoka 819-0395, Japan
hayashi@ed.kyushu-u.ac.jp

Summary

Fatty acid detection is of great importance in medical diagnosis. Consequently, this study explores the possibility of localized surface plasmon resonance (LSPR) sensors combined with titanate sol-gel layers to detect hexanoic acid vapors selectively. AuNPs layers were fabricated on a glass substrate by ion vacuum sputtering method. After annealing, sol-gel molecularly imprinted polymer mixture was spin coated on the AuNPs layers. The results show that the change of transmittance at plasmon peak in spectrum was affected by spin coating speed. When the speed was set as 3000 r/min, a better response was obtained. Besides, no nonspecific absorbance was observed in titanate sol-gel matrix. Thus, LSPR combined with sol-gel layers could be employed to detect HA vapors selectively.

Keywords: Sensors, localized surface plasma resonance, titanate sol-gel layers, hexanoic acid

Experimental

The schematic of sensing mechanism is shown in Fig. 1. In this study, titanate sol-gel layer was prepared by dissolving 136 μL tetrabutoxy titanium as a precursor in 2 mL of iso-propanol and 50 μL hexanoic cacid (HA) was added as template. Besides, 24 μL 3-aminopropyl triethoxysilane (APTES) was added to enhance binding capacity between sol-gel MIP and AuNPs. 25 μL titanium tetrachloride was added to initialized the reaction. Then, the solution was prehydrolyzed at 70 °C for 1 h [1]. A substrate was put into a quick coater for AuNPs deposition, and annealed in air atmosphere at 200 °C for 5 h [2]. Titanate sol-gel layer was applied on the AuNPs film by spin coating 20 μL of solution at a spinning rate of 1000, 3000 and 5000 rpm, respectively. Then, samples were heated at 200 °C for 1 h to remove template from the imprinted layer. The schematic of transmittance spectra measurement system was show in Fig. 2. Fatty vapors were generated by a calibration vapor generating equipment. In this study, the concentrations of propanoic acid (PA), HA and octanoic acid (OA) were 40.93, 21.05 and 11.23 ppm, respectively.

Results and discussion

To investigate the optimal thickness of sol-gel MIP layer, the spectra and sensitivity of sensor samples at spin coating speed at 1000, 3000 and 5000 rpm were measured and analyzed. Fig. 3 show the transmittance spectra of each sample. Compared with the sensors coated with MIP under the same spin coating speed, sensors coated with NIP had a lower λ_{min}. The normalized responses of sensor are show in Fig. 4. It indicated that with the spin coating speed increased, a lower response was obtained. The real-time responses of MIP/NIP LSPR sensors to HA vapors was shown in Fig. 5. It demonstrated that the sample at 1000 rpm need a longer recover time. Besides, no responses were observed on all sensors coated with NIP. It indicated that there is no nonspecific absorbance in titanate sol-gel matrix. Hence, the adsorption capacity of MIP is mostly contributed by the unusual cavities in sol-gel layers. Considering the recover time and response intensity of a sensor simultaneously, the spin coating speed at 3000 rpm would be the optimal condition for detecting HA vapors selectivity. Fig. 6 show the real-time response of HA-MIP coated AuNPs sensors to PA, HA and OA vapors. The result demonstrated that the corresponding response signal of HA is larger than that of PA or OA. It indicated that HA-MIP layers would play a vital role in absorption of HA selectively.

Conclusion

In this study, an AuNPs film combined with titanate sol-gel MIP was successfully utilized for the determination of HA vapors selectivity. It also offers some useful technologies for developing sensors for fatty acid vapors. In addition, a sensor array constructed with various of MIP coated LSPR sensors would be developed for varieties of fatty acid vapors.

Acknowledge

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References

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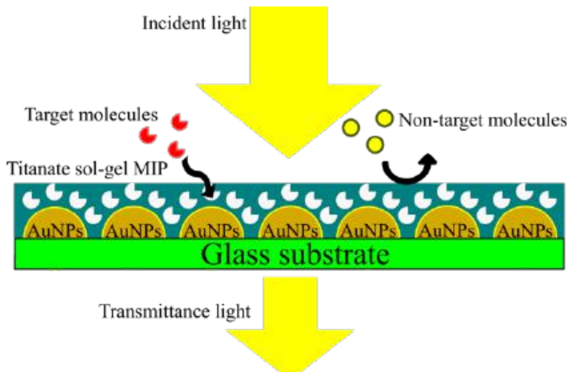

Fig. 1: Schematic diagram of MIP-coated AuNPs film

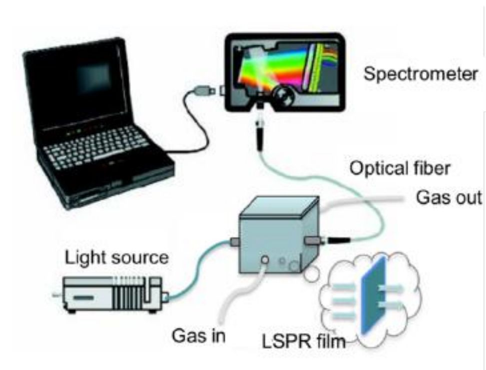

Fig. 2: Schematic diagram of spectra testing system

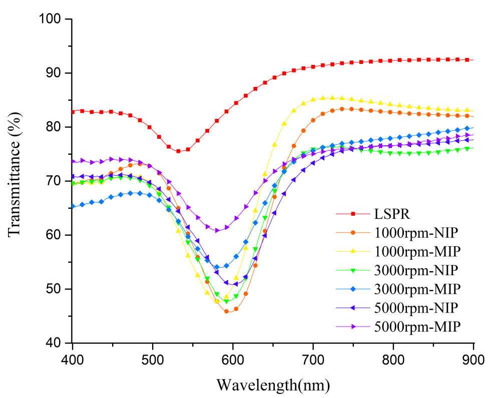

Fig. 3: Transmission spectra of MIP-LSPR sensors.

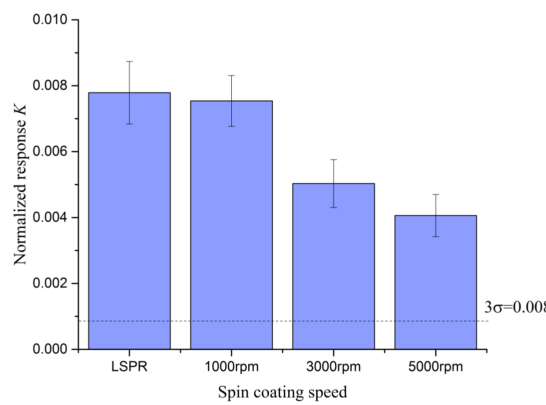

Fig. 4: Normalized responses of MIP-LSPR sensors to HA vapors

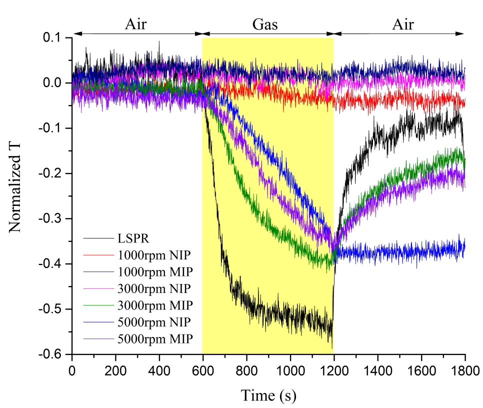

Fig. 5: Real-time response of MIP and NIP with different rpms to HA vapors

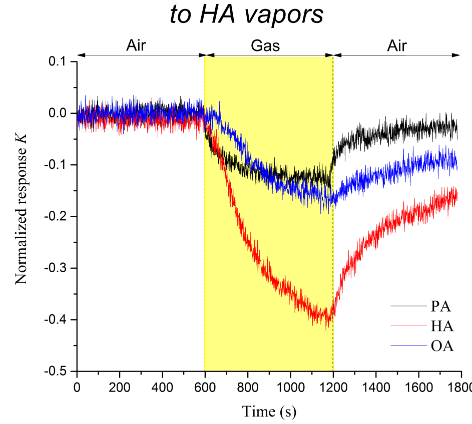

Fig. 6: Real-time response of MIP-LSPR sensor to three fatty acid vapors