Title	Design of MOF based surface plasmon resonance sensors
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NANYANG TECHNOLOGICAL UNIVERSITY

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Project ID: EEE08162
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Design of MOF Based Surface Plasmon Resonance Sensors

Background

Excited by lights, surface plasmons are electromagnetic waves propagating on the metal-dielectric interface. In a waveguide with a metal film, a surface plasmon mode can be coupled with a core-guided mode at a certain wavelength, signified by a sudden increase in losses. The fact that resonance wavelengths are sensitive to changes in the refractive index of the bordering analyte, lies the basis of surface plasmon resonance (SPR) sensors. Furthermore, when embedded into the microstructure of a fiber (MOF), the miniaturized SPR sensors support remote measurement.

Application

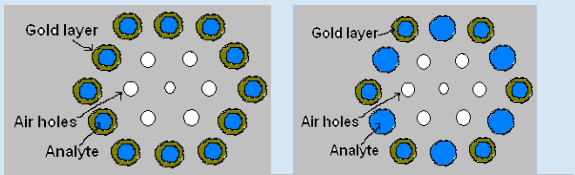
SPR sensors, with the advantage of rapid detection at low concentration, can be used in the detection of biological, chemical analytes, environmental monitoring, medical diagnostics, etc. For example, the detection limit of dioxin is 0.1 ng /mL and the assay is completed in 15 min.

Objective

Design the microstructures of SPR sensor and simulate propagation modes using finite element method. Through the structure optimization, reduce the propagation loss while improving the sensitivity.

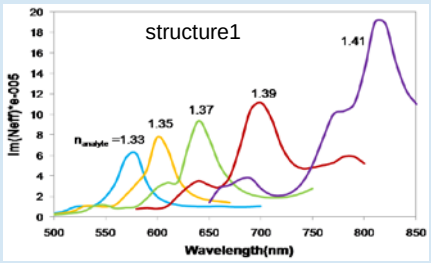
Results

① Validation of the structure

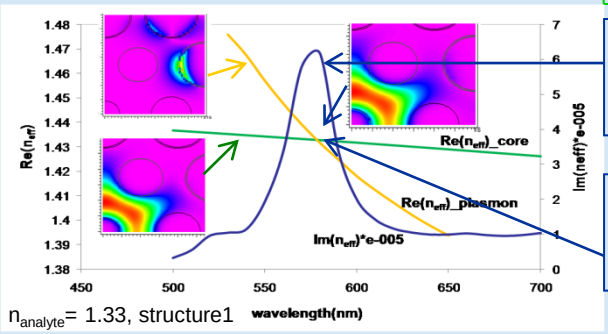


Structure 1 | Structure 2 selective coating

② Sensitivity inspection



Resonance λ shifts to the right as $n_{analyte}$ increases, accompanied by the increase in resonance loss.

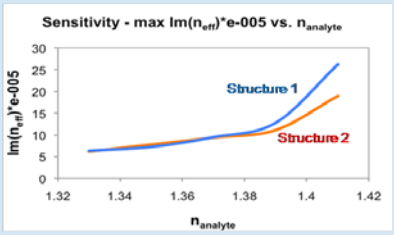


$n_{analyte}$= 1.33, structure1

Loss α Im(n_{eff}). max Im(n_{eff}) => max loss => coupling occurs.

Mathematically, coupling requires n_{eff}_core = n_{eff}_plasmon.

Coupling occurs at 570nm => the structures are valid as SPR sensors.



Resonance losses of structure 2 are higher than that of structure 1 i.e. the signals would be more easily distinguished from noise.

Conclusion

The simulation of two MOF based SPR sensors demonstrated the effectiveness of their sensing ability. Further modification can be made to improve the sensitivity , to simplify the structure, to reduce the analyte consumption, etc.

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Supervisor: Prof. Shum Ping **Collaborators: Dr. Zhang Ying & Dr. Yu Xia**