Plasmonic Biosensors for Ambient Viruses and Bacteria

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Abstract (Arial 11)

The tiny invisible airborne pathogens, especially viruses, bacteria and their components, may cause health impacts even with minute amount. My group has developed sensors for total bioaerosol quantification [1] and for highly accurate SARS-CoV-2 detection [2].

To quickly evaluate the total bioaerosols concentration, we developed a localized surface plasmon resonance (LSPR) biosensor based on succinimidyl-ester-functionalized gold nanoislands (SEF-AuNIs) for quantitative bioaerosols detection. The detection limit of our proposed SEF-AuNIs sensors for model bacteria *E. coli* and *B. subtilis* can go to 0.512 cells/ml and 1.69 cells/ml respectively. To demonstrate the capability of this bioaerosols sensing technique, we tested aerosol samples collected from Bern (urban station), Basel (suburban station) and Rigi mountain (rural and high altitude station) in Switzerland, and further investigated the correlation with endotoxin and PM10. The results substantiated that our SEF-AuNIs sensors could be a reliable candidate for total bioaerosols detection and air quality assessment.

Our dual-functional plasmonic biosensor combining the plasmonic photothermal (PPT) effect and LSPR sensing transduction provides a promising solution for COVID-19 virus detection. The AuNIs functionalized with complementary DNA receptors can perform a sensitive detection of the selected sequences from SARS-CoV-2 through nucleic acid hybridization. For better sensing performance, the thermoplasmonic heat is generated on the same AuNIs chip when illuminated at their plasmonic resonance frequency. The localized PPT heat is capable to elevate the in situ hybridization temperature and facilitate the accurate discrimination of two similar gene sequences. Our dual-functional LSPR biosensor exhibits a high sensitivity with the lower detection limit down to the concentration of 0.22 pM and allows precise detection of the specific target in a multi-gene mixture. The virus sensor can serve as an alternative to the standard PCR methods for COVID-19 diagnosis, but more prominently, may provide fast and continuous monitoring of the ambient viruses.

REFERENCES

[1] Qiu, G., Yue, Y., Tang, J., Zhao, Y-B., Wang, J. *Environmental Science and Technology*, 2020, 54, 3, 1353-1362, https://dx.doi.org/10.1021/acs.est.9b05184.
[2] Qiu, G., Gai, Z., Tao, Y., Schmitt, J., Kullak-Ublick, G.A., Wang, J. *ACS Nano*, 2020, https://dx.doi.org/10.1021/acsnano.0c02439

FIGURES

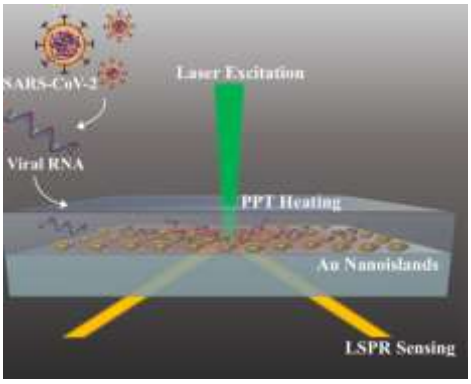

Figure 1: Dual-functional plasmonic biosensor combining the PPT effect and LSPR sensing.