Plasmonic nanorattles for in situ SERS imaging of pH in microbial colonies

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It is well known that microbial populations and their interactions are largely influenced by their secreted metabolites. For instance, microbial fermentation processes often lead to the production of acids that can lower the local pH significantly, thus affecting the physiological state of resident microbes [1], promote resistance to antibiotics [2] or induce enamel demineralization and dental caries [3]. Therefore, non-invasive and simultaneous monitoring of extracellular bioactive metabolites and physicochemical factors (e.g. pH) can provide valuable information regarding the mechanisms that regulate the biogenesis, composition, and function of microbial communities. Herein, we report a SERS substrate consisting in plasmonic Au@Ag@mSiO$_2$ nanorattles embedded within an agar matrix for pH sensing in bacterial colonies. This multifunctional SERS substrate enabled us to efficiently perform spatiotemporal non-invasive detection and imaging of pH changes in colonies of Escherichia coli.

References

[1] Stewart, P. S.; Franklin, M. J., Nat. Rev. Microbiol., 6 (2008) 199-210.
[2] Wilton, M.; Charron-Mazenod, L.; Moore, R.; Lewenza, S. Antimicrob. Agents Chemother., 60 (2016) 544-553.
[3] Xiao, J.; Hara, A. T.; Kim, D.; Zero, D. T.; Koo, H.; Hwang, G., Int. J. Oral Sci., 9 (2017) 74-79.

Figures

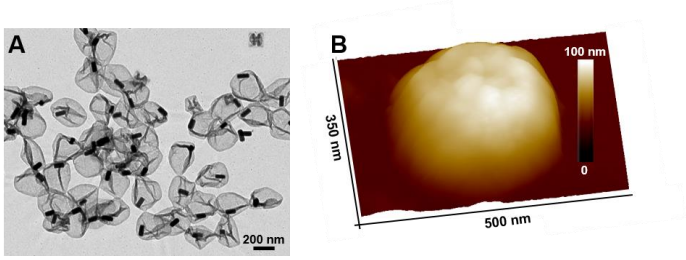

Figure 1: (A) TEM image of plasmonic mSiO$_2$ nanorattles. (B) AFM topographic 3D height image of a hydrated plasmonic mSiO$_2$ nanorattle.

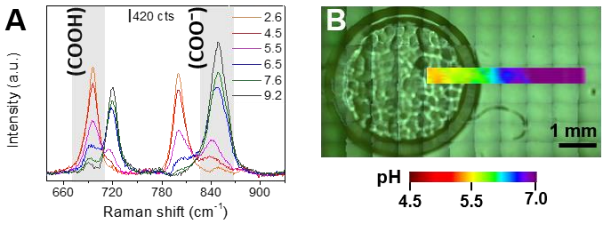

Figure 2: (A) SERS spectra of nanoratles@LB-agar substrates at different pHs. (B) Spatiotemporal pH distribution map of a selected area of the nanorattles@LB-agar substrate during the growth of a colony of E. coli.