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Block Copolymer Assembled Mesoporous Materials Architectures for Biosensing Applications

Tuesday, 11 October 2022 14:00 (20 minutes)

Block copolymer self-assembly provides effective routes for the precise structural arrangement of inorganic materials architectures, either via templating or co-assembly. In my talk, I want to provide an overview of how we exploit formation principles in 2D and 3D to tailor mesostructured electrodes for biosensing applications. We have recently developed an approach, based on quartz crystal microbalance with dissipation monitoring (QCM-d), for the stepwise functionalisation of surfaces immobilisation and subsequent uptake and release of binding partners.[1] This is an ideal platform to study extracellular vesicles (EVs), with the potential to be used biomarkers for disease diagnostics via liquid biopsies from readily accessible bodily fluids.[2,3] To this end, we studied the effect of nanostructured gold arrays compared to flat sensing surfaces.[4] Crucially, we find that the nanostructuration significantly enhances the detection sensitivity, and that gold islands matched to the lengthscale of the binding partners outperform smaller arrays. We hypothesise that the creation of such confined sensing regions interspersed by non-binding silica, provides optimal spatial orientation with reduced steric effects and negative cooperativity of grafted antibodies.
In a separate line of research, we are exploiting the capability of block copolymers to structure-direct inorganic films for electrochemical biosensing within mesoporous architectures. The integration of mesoporous films with finely controllable pore characteristics allows to detect target analytes by immobilisation within the mesoporous network, where trapping events and associated
pore blockage can be conveniently read out by electrochemical means. Herein, the formation of tailored inverse opal-type pore arrangements enabled the reliable detection of E. coli DNA.[5,6]

[1] Nanoscale, DOI: 10.1039/C9NR03162F, 2019.
[2] Analytical Chemistry, DOI: 10.1021/acs.analchem.9b05736, 2020.
[3] Analytical Chemistry, DOI: 10.1021/acs.analchem.1c04282, 2022.
[4] In review, available as preprint: DOI: 10.26434/chemrxiv-2022-609ck.
[5] In review, available as preprint: DOI: 10.26434/chemrxiv-2022-c0plp-v2.
[6] In preparation for submission.

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