Carbon-stabilised porous silicon nanostructures to build the next generation of diagnostic tools

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To create the next generation of diagnostic tools based on nanostructured electrochemical biosensors, tuning of the morphological features and electrochemical properties of the transducer is key. Our approach to design highly performing sensing devices harnesses porous semiconductors fabrication, and their carbon stabilisation and site-directed functionalisation. We have developed arrays of nanochannels for the label-free detection of pathogens, and arrays of nanoneedles used as skin patches for minimally invasive biomarkers detection.

Key to the development of this new class of nanostructured biosensors is our recent work on carbon-stabilised porous silicon (pSi) [1-3]. The versatility of the sensing platform is herein exemplified by a unique carbon-stabilised pSi double-layer nanostructure fabricated via a two-step electrochemical anodisation process. The pore morphological features (e.g. pore size, depth and porosity) at each pSi layer are easily adjusted by simply varying the anodisation parameters. Next, different types of carbon with tailored hydrophilicity and surface chemistry are formed *in situ* onto each layer via stepwise temperature-controlled decomposition of acetylene. Double-layer structures with distinct functionalities on each layer are harnessed for site-specific modification of bioreceptors. These platforms not only feature remarkable geometrical properties, but also versatile surface chemistry, dual surface functionality, and excellent electrochemical properties. The latter is underpinned by the fast electron-transfer kinetics, low double-layer capacitance and high sensitivity they show. The potential of carbon-stabilised pSi double-layer structures as novel highly performing biosensors is here demonstrated by the development of voltammetric sensors for the detection of relevant viruses and nucleic acid biomarkers.

References

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Figures

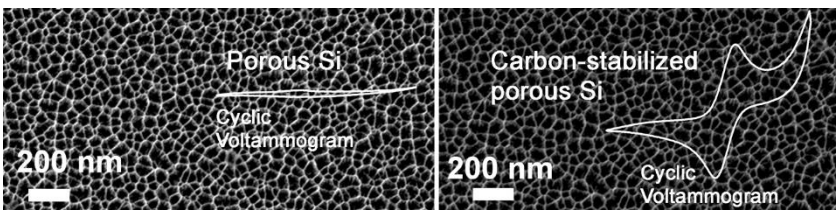

Figure 1. SEM images and cyclic voltammograms of a pSi substrate prior and after carbon stabilisation.