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 paramount. Our approach to design highly performing sensing devices harnesses the knowledge acquired to fabricate layers of porous semiconductors that can be carbon-stabilised and site-specifically functionalised, to adjust their electrochemical properties and biorecognition capabilities.
Key to the development of this new class of nanostructured biosensors is our work on carbon-stabilised porous silicon (pSi) [1-3]. The potential of this material for electrochemical sensing is herein exemplified by a unique carbon-stabilised pSi double-layer nanostructure fabricated via a two-step electrochemical anodisation process. [4] The pore morphological features (e.g. pore size, depth and porosity) at each pSi layer are precisely defined by simply varying the anodisation parameters. Next, different types of carbon with tailored wettability and surface chemistry are formed *in situ* on the pore walls of each layer via stepwise temperature-controlled acetylene decomposition. 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 excellent electrochemical performance, underpinned by their fast electron-transfer kinetics, low double-layer capacitance and high sensitivity. The potential of carbon-stabilised pSi double-layer structures as novel highly performing biosensors is here demonstrated by developing a voltammetric sensor for the detection of key nucleic acid biomarkers.

References

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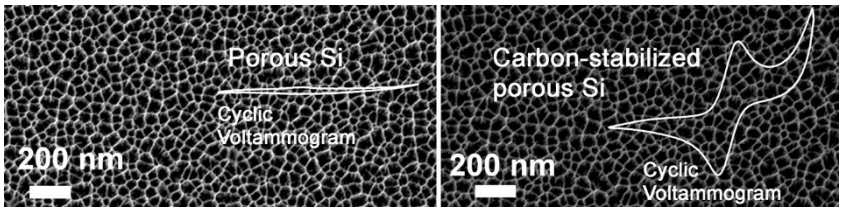

Figure 1: Scanning electron microscopy images and cyclic voltammograms of a pSi substrate prior and after carbon stabilisation.