Tailor-Designed Nanostructured CeO_2-Au Thin Films for Non-Enzymatic Electrochemical Glucose Sensor

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Gold is a key component in the advancement of the future of some biomedical and electrochemical technologies. The electrochemical oxidation of glucose is a major concern in medical sensors for diabetes diagnostics and management. Non-enzymatic electrochemical oxidation of glucose is being sought as an alternative to enzymatic glucose oxidation but also in the hope of enhancing the electrocatalytic activity and lifetime towards the oxidation of glucose.

This work centers on developing advanced free-standing nanoarchitectured layers including the current collector, the catalyst and the catalyst support for non-enzymatic electrochemical glucose sensors. These nanoarchitectures are made of Au nanoscaled films deposited directly onto nanoscaled cerium dioxide (CeO_2) itself deposited on a current collector: carbon microfibers (CMF) substrates. The syntheses of Au and CeO_2 films were achieved by means of the pulsed laser deposition (PLD) technique. Several of the conditions for PLD deposition were varied, i.e., the loading and the background atmosphere (vacuum, helium, and oxygen). Such conditions allowed us to obtain various interesting morphologies of CeO_2 (Fig. 1) and Au (Fig. 2).

In this talk, we will report the structure-electrocatalytic properties relationship associated with these nanostructures. These insights were obtained using a myriad of physico-chemical characterization techniques such as SEM, TEM and HR-TEM, XPS, MicroRaman, and XRD combined with electrochemical studies for glucose electrooxidation. The electrochemical oxidation of glucose was performed in a pH 7.0~7.3 phosphate buffer solution containing various concentrations of glucose using cyclic voltammetry (CV) and square wave voltammetry (SWV).

Examples of CVs run with 50 mV/s in 100 mM glucose + PBS at CeO_2/Au electrodes are shown in Fig. 3. CeO_2 was deposited under vacuum (UV), 10 mT of O_2 and 0.5 T of He, whereas Au was deposited under 2 T of He. All electrodes exhibited well defined glucose electrooxidation features. It can be further seen that in all cases, CeO_2 improved the catalytic activity of Au. Interestingly, the morphology of CeO_2 had a great effect on the electroactivity. Indeed, for the examples shown in Fig. 3, Au supported by CeO_2 deposited under O_2 atmosphere delivered the highest current density and the lowest onset oxidation potential of glucose.

More details regarding the physico-chemical properties of various Au-based CeO_2 structures and their prospective use as glucose electrochemical sensors electrodes will be reported at the meeting.

Acknowledgements
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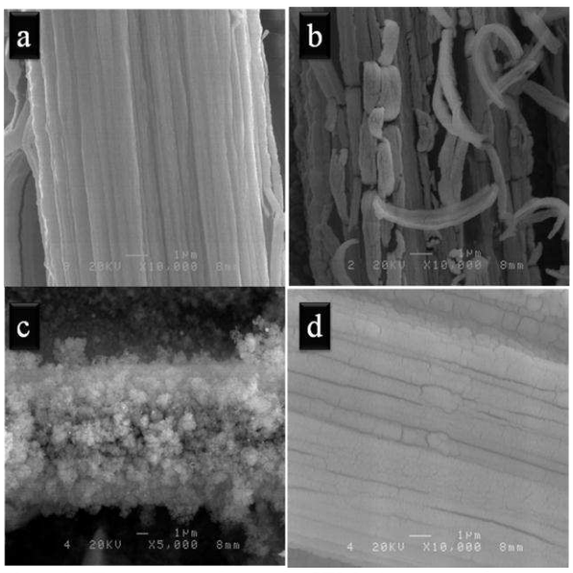

Fig. 1 Few examples of SEM images of room-temperature PLD-CeO_2 films deposited: (a) under vacuum, (b) 10 mT of O_2, (c) 2T of He and (d) 0.5 T of He.

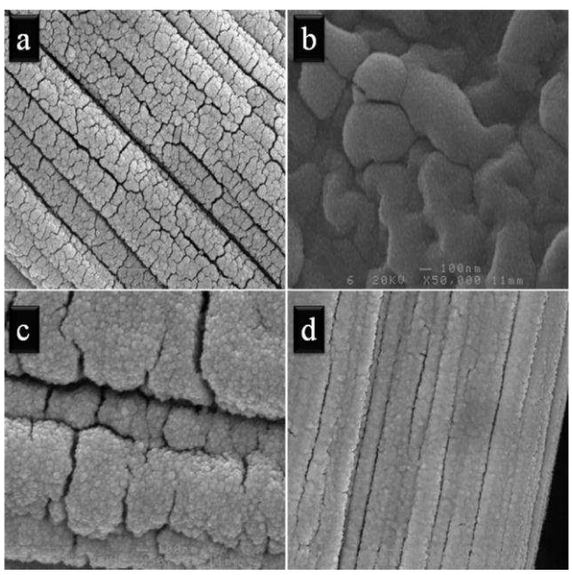

Fig. 2 Few examples of SEM images of room-temperature PLD-Au films deposited onto CeO_2: (a) CeO_2 (0.5 T He)/Au (2 T He), (b) CeO_2 (10 mT O_2)/Au (2 T He), (c) CeO_2 (0.5 T He)/Au (0.5 T He) and (d) CeO_2 (0.5 T He)/Au (UV).

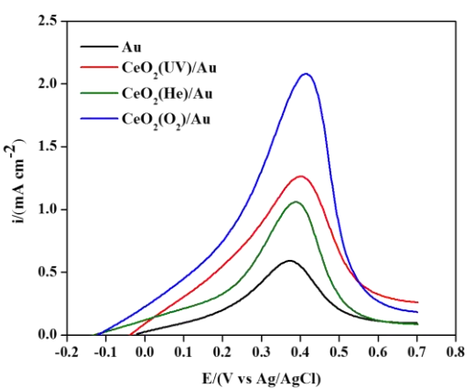

Fig. 3 Effect of CeO_2 morphology on Au electroactivity. Cyclic voltammograms recorded in 100 m M glucose+ PBS solution at a scan rate of 50 mV/s.