Accepted Manuscript

Towards a subcutaneous optical biosensor based on thermally hydrocarbonised porous silicon

Wing Yin Tong, Martin J. Sweetman, Ezzat R. Marzouk, Cara Fraser, Tim Kuchel, Nicolas H. Voelcker

PII: S0142-9612(15)00796-6

DOI: 10.1016/j.biomaterials.2015.09.045

Reference: JBMT 17095

To appear in: *Biomaterials*

Received Date: 10 June 2015

Revised Date: 28 September 2015

Accepted Date: 29 September 2015

Please cite this article as: Tong WY, Sweetman MJ, Marzouk ER, Fraser C, Kuchel T, Voelcker NH, Towards a subcutaneous optical biosensor based on thermally hydrocarbonised porous silicon, *Biomaterials* (2015), doi: 10.1016/j.biomaterials.2015.09.045.

Towards a subcutaneous optical biosensor based on thermally hydrocarbonised porous silicon

Wing Yin Tong[1], Martin J. Sweetman[1], Ezzat R. Marzouk[2&3], Cara Fraser[4], Tim Kuchel[4], Nicolas H. Voelcker[1+]

[1]ARC Centre of Excellence in Convergent Bio-Nano Science and Technology, Mawson Institute, University of South Australia, South Australia, Australia

[2]Centre for Environmental Risk Assessment and Remediation, University of South Australia, South Australia, Australia

[3] Faculty of Environmental Agricultural Sciences, Suez Canal University, North Sinai, Egypt

[4]South Australian Health and Medical Research Institute, South Australia, Australia

+Correspondences should be sent to:
Nicolas H. Voelcker (Nico.Voelcker@unisa.edu.au)

Abstract

Advanced biosensors in future medicine hinge on the evolvement of biomaterials. Porous silicon (pSi), a generally biodegradable and biocompatible material that can be fabricated to include environment-responsive optical characteristics, is an excellent candidate for *in vivo* biosensors. However, the feasibility of using this material as a subcutaneously implanted optical biosensor has never been demonstrated. Here, we investigated the stability and biocompatibility of a thermally-hydrocarbonised (THC) pSi optical rugate filter, and demonstrated its optical functionality *in vitro* and *in vivo*. We first compared pSi films with different surface chemistries and despite the outstanding stability of the THC pSi films, the material was found to be cytotoxic. We then showed that the cytotoxicity correlates with reactive oxygen species levels, which could be mitigated by pre-incubation of THC pSi (PITHC pSi). PITHC pSi facilitates normal cellular phenotypes and is biocompatible *in vivo*. Importantly, the material also possesses optical properties capable of responding to microenvironmental changes that are readable non-invasively in cell culture and subcutaneous settings. Collectively, we demonstrate, for the first time, that PITHC pSi rugate filters are both biocompatible and optically functional for lab-on-a-chip and subcutaneous biosensing scenarios. We believe that this study will deepen our understanding on cell–pSi interactions and foster the development of implantable biosensors.

Keywords: Silicon, Cytotoxicity, Biocompatibility, Biosensor, Biodegradation, Subcutaneous implant

1 Introduction