Re-Etched anodized porous silicon: from drug delivery to optical applications

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Hierarchically nanostructured silicon can be produced by regenerative electroless etching [1] (ReEtching) of initially anodized porous silicon (RAPSi) [2]. The ReEtched material retains its characteristic anodized mesopores, upon which tortuous 2–4 nm pores have been introduced throughout the pore walls. The walls become sufficiently narrow to support quantum-confined crystallites that are brightly photoluminescent. The regenerative nature of the ReEtching process also provides control over the emission color of the photoluminescence. Mechanical milling and hydrosilylation of this still hydrogen terminated PSi powder with undecylenic acid can be used to produce hydrolytically stable nanoparticles of ~220 nm in diameter. The nanoparticles exhibit robust and bright luminescence that can be excited with either a single ultraviolet/visible photon or even with two near infrared (NIR) photons. The application of two-photon fluorescence imaging for obtaining higher spatial resolution, contrast and the suppression of tissue autofluorescence has received significant interest. This feature is highly beneficial, not only for *in vitro* cell studies or for histopathological studies of tissue, but due to the better tissue penetration of NIR photons, it can also be applied in *in vivo* time-gated fluorescence imaging of small animals as well [3].

In addition to the significantly larger specific surface area of RAPSi, which can reach over 1000 m^2/g, an important feature when considering drug loading and release, there is also another, recently discovered effect of ReEtching of anodized PSi. ReEtching of anodized PSi Bragg reflector multilayer structure suppresses the sidelobes, characteristic for Bragg mirrors in a very similar fashion as in rugate filters when produced with *e.g.* an apodization function or index matched layers (Figure 1). Technically, ReEtching of anodized Bragg reflectors is simpler than direct rugate filter fabrication, and this offers more freedom to adjust e.g., the reflection bandwidth. Moreover, the reflectors can be made to exhibit similar luminescence properties as the nanoparticles.

References

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Figures

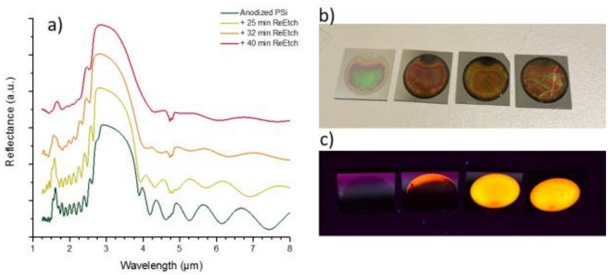

Figure 1: a) Reflection band changes during the ReEtching. b) The reflectors under normal illumination and c) under UV excitation (365 nm).