Photo-Assisted Dissolution of Porous Silicon Nanostructures in HF Solutions Monitored by Photoconduction

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Porous silicon (PSi) formed by electrochemical etching of lightly-doped silicon substrates in hydrofluoric acid (HF) exhibits a sponge-like nanostructure. It has potential applications in optoelectronics and photovoltaics because of new properties emerging from quantum confinement (QE), such as light emission and tunable optical absorption. After PSi formation, further chemical dissolution in HF can be used to increase the porosity. In an earlier work, we have used photoconduction to monitor the chemical dissolution of PSi in solutions containing HF [1,2]. The study also allowed the derivation of the PSi absorption coefficient for a very wide range of porosities, as well as the Si dissolution rate for various HF concentrations [2]. For high HF concentrations the chemical dissolution is very slow. In such case, dissolution can still be obtained at a rather high rate under illumination by photo-generation of holes in the PSi structure. We have studied the photo-assisted dissolution of PSi using the monitoring technique previously shown [1,2]. The effects of PSi thickness, illumination power and wavelengths were investigated. The photo-dissolution rate as a function of illumination power was found to reach a saturation state. As an illustration, Fig. 1 shows the time evolution of the photocurrent during PSi photo-dissolution for different illumination powers. A saturation current was observed when the whole PSi layer had been dissolved. Almost no difference can be seen in the dissolution time, showing no noticeable dependence of the photo-dissolution rate on illumination power. On the other hand Fig. 2 shows a big difference when using much lower illumination powers locally in PSi. A model was also developed.

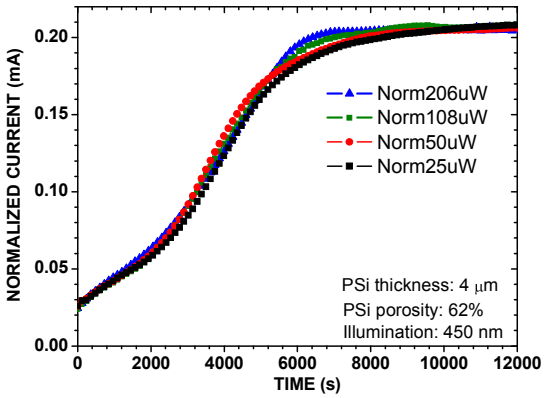

Fig.1: Normalized photocurrent as a function of photo-dissolution time for different illumination powers at 450 nm.

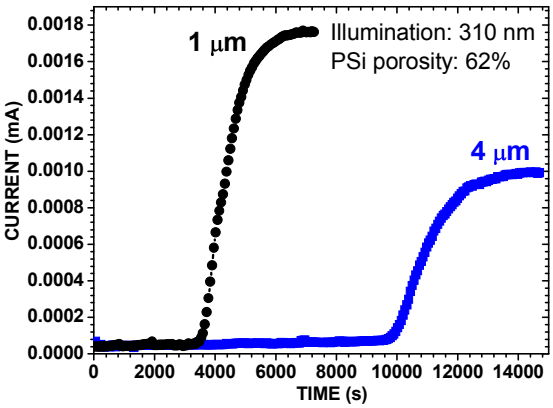

Fig.2: Photocurrent as a function of photo-dissolution time for different PSi thicknesses at 310 nm.

[1] B. Gelloz, H. Fuwa, and L. Jin, ECS Journal of Solid State Science and Technology **5** (3), 190 (2016)
[2] B. Gelloz, K. Ichimura, H. Fuwa, E, Kondoh and L. Jin, ECS Journal of Solid State Science and Technology **6** (1), R1-R6 (2017)