光伝導計測による電気化学酸化中のポーラスシリコンの発光および光吸収現象の観測

Luminescence and Optical Absorption of Porous Silicon during Electrochemical Oxidation monitored by Photoconduction

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Recently, we have shown how photoconduction can be used to monitor the evolution of porous silicon (PSi) in HF solutions (dissolution; photo-dissolution) [1, 2]. The principle is based on the photocurrent being a signature of light transmission through PSi and thus probing changes in optical absorption. Here, we use the photoconduction technique to study the electrochemical oxidation (ECO) of p-type PSi. The photocurrent, electroluminescence (EL) and photoluminescence (PL) were acquired in-situ. An example is shown in Fig. 1. The photocurrent increases as the oxidation progresses since the formed oxide is transparent at the 405 nm light. A model was developed to explain the progress of the photocurrent, where one fitting parameter was used: the valence of Si oxidation for the ECO reaction. Our experiments led to a value of ~1.5 for this valence. It is lower than the value of 4 expected for full silicon oxidation, but is rather in agreement with non-stoichiometric oxidation of Si, which was expected in these particular experiments (ECO leads to only oxygen incorporated in back-bond). Our model allows for the derivation of the evolution of the optical absorption and porosity during ECO. The evolution of the EL and PL was in agreement with previous reports. The PL increases during ECO as a result of increased quantum confinement in the PSi structure. ECO ends when the oxide formed at the PSi/substrate interface prevents further current flow. Our results suggest that the PL could still be further increased if ECO could continue beyond this stage. The porosity corresponding to highest PL efficiency may be estimated by this method.

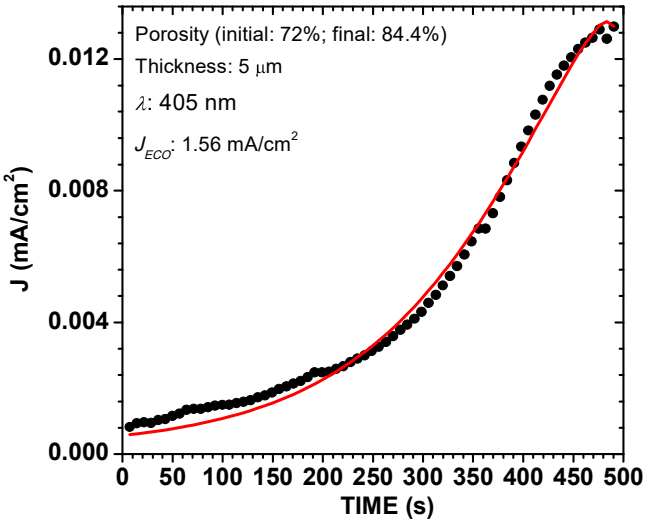

Figure 1: Circles: photocurrent (illumination at 405 nm) during ECO at indicated current density of a PSi layer (initial porosity: 72%; thickness: 5 μm). Solid line: fit using a model, which will be discussed.

[1] B. Gelloz et al. ECS Journal of Solid State Science and Technology **6** (1), R1 (2017)
[2] B. Gelloz et al. ECS Journal of Solid State Science and Technology **7** (12), P730 (2018)