マイクロ生体電池向けのバイオミメティック毛細管ポンプの開発

Characterization of biomimetic capillary pumps aimed at biofluid-powered microbatteries

東北大学 [1], ○シュタウス スヴェン [1], 本間格 [1]

Tohoku Univ. [1], °Sven Stauss[1] and Itaru Honma[1]

E-mail: sven.stauss.d2@tohoku.ac.jp

Biofluid-powered, biocompatible microbatteries[1–5] possess a high potential as energy sources for microsystems, enabling new opportunities in applications ranging from medical implants and health monitoring devices to environmental sensing. By using biocompatible electrodes and electrolytes that activate the battery at the instant when it has to be powered on, bulky encapsulation of the battery is not required anymore. However, control over the absorption of the electrolyte into the microbattery is often not possible, and the entrapment of gas bubbles can lead to failure of the microbattery.

Here we demonstrate the development and characterization of biomimetic capillary pumps[6,7], to enable effective and more controlled aspiration of electrolytes into biocompatible microbatteries. Microreservoirs containing biomimetic microstructures (in the form of drops, lozenges, ellipses, etc.) with typical characteristic length scales of 20–80 μm were realized in Si by standard photolithography followed by deep reactive ion etching to depths of 150–200 μm. The Si wafers were then anodically capped with a glass wafer, before dicing them into individual chips with dimensions of 5×5 mm^2.

The performance of the capillary pumps was characterized by high-speed imaging, using simulated gastric fluid as liquid. It was found that the capillary pumps reduced the risk of gas bubble entrapment during absorption of the electrolyte into the microreservoirs. Moreover, the speeds at which the liquid was drawn into the microreservoirs and the times required to fill them (of the order of ~50–250 ms) could be adjusted by controlling the geometry, spacing, and arrangement of the biomimetic microstructures. It is expected that these types of capillary pumps could also be useful for other types of applications, where controlled absorption of a fluid is required.

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