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Development of paper-based medical check-up sensor using ink jet printing

Title in Japanese is required

インクジェット印刷技術を用いた紙基板健康診断チップの開発

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Number to give a comment in the footnote.

[Introduction]

"Lab-on-Paper" is a new type of paper-based microchips with microchannels mounted, and has recently attracted soaring attention to new point-of-care devices. Paper is a material appropriate for manufacturing home healthcare chips especially in developing countries because it is environmentally friendly, abundant, inexpensive, recyclable and disposable. As shown in Figure 1, a microchannel built in the device represents a unique concept that this system requiring only a small volume of liquid sample without any pumping equipment because the liquid flows in the microchannel spontaneously by capillary force. The possibility to perform simultaneous multiple assays is also one of the features of the microchannel layout.

[Experimental]

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We used a material printer (Dimatix DMP-2831, Fujifilm, JAPAN), a printer for research applications. PEDOT:PSS electrodes were fabricated as working and counter electrodes. Silver electrodes were also fabricated as reference electrodes. Unless otherwise stated, all chemicals were obtained from Wako Pure Chemical Industries (Osaka, Japan), Tokyo Chemical Industry Co., Ltd. (Tokyo, Japan), or Sigma-Aldrich (St-Louis, USA). PEDOT:PSS electrodes were fabricated in the following process. PEDOT:PSS (Clevios P Jet HC, H.C. Starck GmbH, Frankfurt, Germany) was diluted to 0.3-fold concentration with a 10% (v/v) ethylene glycol aqueous solution (PEDOT:PSS ink). Ultra-pure water (Millipore, Billerica, USA) was used for dilution. The PEDOT:PSS ink was printed on the liquid-transport paper. Silver electrodes were fabricated in the following process. To avoid the process of heating at a high temperature, the in situ reduction method of Ag ion previously reported (Bidoki et al. 2007) was applied. A 340 g/L sodium ascorbate aqueous solution prepared as a reducing ink was printed first on the paper substrates. Then, a 500 g/L silver nitrate - 10% (v/v) ethylene glycol aqueous solution prepared as an Ag ink was printed exactly on the same location with the reducing ink.

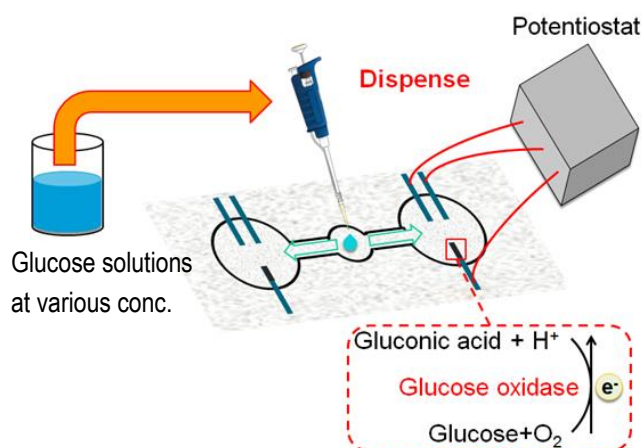


Fig. 1 Schematic of paper-based health care chip

[Results and discussion]

We established a novel fabrication method for lab-on-paper. Due to the integration of several unique technologies, the realistic fabrication method applicable to industrial manufacturing process was demonstrated: (i) in order to improve printability of substrate, high density fluid-transport paper was successfully prepared from a highly-beaten cotton linter pulp, (ii) three kinds of electrodes were fabricated respectively by printing on the paper substrate, (iii) microfluidic patterns were fabricated on the paper substrate surface by exposure to UV light after ink jet printing of hydrophobic UV-curable inks, and (iv) PDA nanoparticles were successfully prepared and printed at the foot of the electrodes for enzyme immobilization and mediator. By using lab-on-paper fabricated as described above to detect concentrations of glucose solutions, electrochemical response could be successfully achieved.