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# Fabrication of monolithic electro-fluidic glass microchips using femtosecond laser

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Integration of microelectric components into microfluidic chips is one of key techniques for increasing performance of lab-on-a-chip devices, which enable us to perform space-selective control of temperature, electric-and magnetic-field manipulation of biological samples, etc. Femtosecond (fs) laser direct-write technique, due to its unique capability of multiphoton-excitation process based on nonlinear absorption, has exhibited intrinsic advantages on facile fabrication and rapid prototyping of 3D microfluidic structures in glass materials over existing conventional techniques. We previously reported that space-selective metallization of the inside of 3D glass microfluidic structures could be realized using femtosecond laser ablation followed by electroless plating [1]. In this paper, we extend this technique to fabricate electrofluidic microchips based on monolithic integration of conductive metallic microstructures in microfluidic channels using successive 3D fs laser direct-writing technique. Femtosecond laser direct writing followed by thermal treatment and successive chemical etching allows us to fabricate 3D microfluidic structures inside photosensitive glass. Then, the fs laser ablation followed by electroless metal plating enables flexible deposition of patterned metal films on desired locations of both sidewalls and internal walls of fabricated microfluidic structures as illustrated in Fig. 1a. To show the applications of such electrofluidic chips, we fabricate a microreactor to control the temperature at the localized area in the microfluidics, which successfully demonstrate enhancement of chemical reactions (see Fig. 1b). Furthermore, the electric manipulation of microorganisms such as electro-orientation and electro-taxis using the fabricated chips is demonstrated.

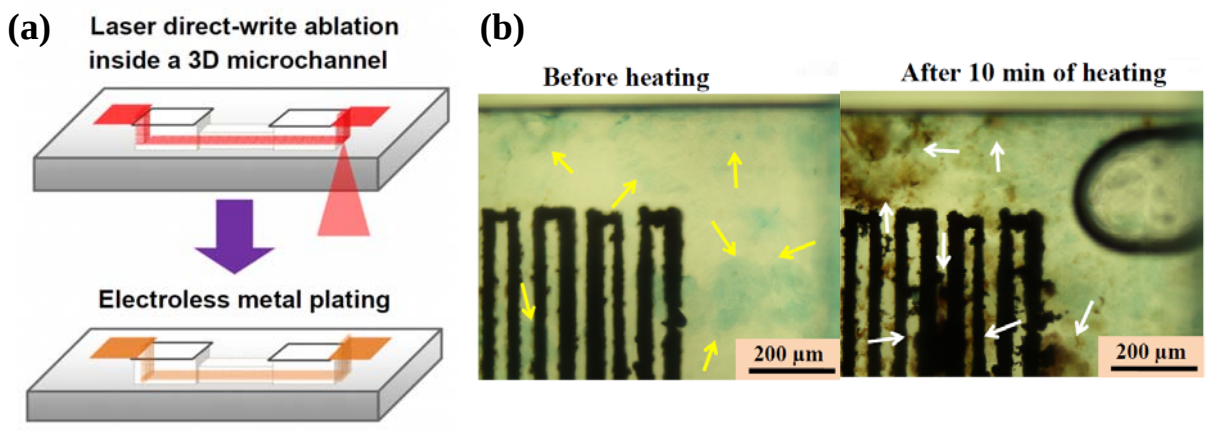


Figure 1 (a) Schematic of laser direct writing and metal patterning for the fabrication of electrofluidic glass microchip. Red and brown regions show the direct-write trajectory of the laser beam and space-selectively deposited metal structures by electroless metal plating, respectively. (b) Acceleration of chemical reaction in microchannel before heating (arrows indicate copper (II) hydroxide particles) and after 10 min of heating (arrows indicate copper (II) oxide particles). Square-wave shape lines in (b) are a part of the in-channel microheater.

[1] J. Xu, *et al.*, The 60th Spring Meeting of The Japan Society of Applied Physics, Tokyo, March (2013).