Biomimetic micro-collector based on ionic polymer metal composite

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Summary
This paper proposes a micro-collector based on ionic polymer metal composite (IPMC) for using in blood vessel. The basic structure and operation principle of the micro-collector is similar to umbrellas that fabricated by paper. For using in blood vessel, to prevent bubbles occurrence due to electrolysis, we coated IPMC with SU-8 (biocompatible [1] photosensitized polymer). For checking application possibility of MEMS technology, we had some basic experiment as IPMCs reaction test with several metal etchants. And to get exact size and for minimize of damage of IPMC component, we conceive proposed novel cutting method of IPMC. To fabricate micro-collector, we made proto-type models and measure its characteristic and performance.

Motivation
Chronic total occlusion (CTO) is a kind of heart disease and to cure surgeon used stent and diamond drills. But during operation, CTOs particles were separated from wounded parts and it can bring about re-strangulation. So we need some actuators for catch these particles, and if we can catch and bring out these particles from humans body, then pathologist can analyze about CTO. For many years, electroactive polymers (EAP) received many attentions due to its extraordinary characteristics. Especially ionic polymer metal composite (IPMC) focused for used as biocompatible actuator materials due to its merit as low driving input voltage, large displacement, flexibility, and can use aqueous environment [2-3]. But IPMC had a defect that when driving voltage was given to IPMC, then bubbles were occurred from IPMCs platinum electrode parts due to electrolysis of water. For use in human body, we coated IPMC with SU-8 to used micro electro mechanical system (MEMS) technology.

Result
To fabricate micro collector, we manufactured IPMC through non-electroplating method and measured its characteristic. To simplified collectors manufacturing process, we produced various types of single body samples and had motion experiment. In consequence, sample of single body types total displacement was decreased, due to samples non symmetry and non uniformity of platinum electrode of IPMC. We decide collection mechanism and design (fig.1) to consider with collectors ultimate propose and experiment result. (fig.2) For using in human body, we must isolated bubble it was occurred on IPMCs electrode, we coated with SU-8 polymer. Before fabricate this process we used ANSYS, the commercial FEM to check the effect of SU-8 by displacement. As a result, we noticed that the displacement was decreased about 15%. To apply MEMS technology, we had IPMC samples reaction experiment with Al etchant and Cr etchant. In consequence, with Al etchant showed 10~30% decrease of displacement and Cr etchant caused over 80% decrease of displacement. To check how long time IPMC stand at bake temperature, (125) we used hot plate. As a result, bake process caused IPMCs displacement decrease, but we soaked baked sample in water or salt solution, then displacement recovered near 90% of normally IPMC displacement. To fabricated collectors body, we treated Teflon for used CNC machine and set the IPMC component in a Teflon body. Detail work will be presented at the conference.

Acknowledgments
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References
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[2] Jennifer W. L. Zhou, et. al. TRANSACTIONS ON MECHATRONICS, VOL. 9 (2004) 334-342.
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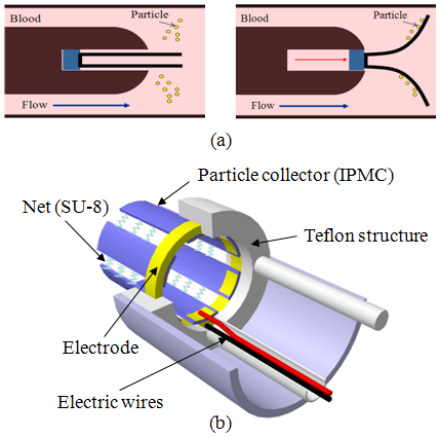

Figure 1. Design (b) and operation principle (a) of micro-collector

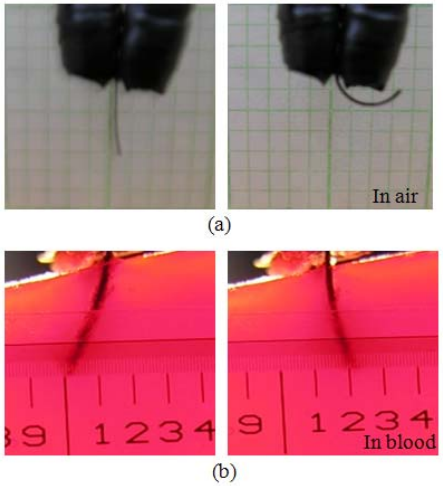

Figure 2. Displacement experiment of a micro-collector using IPMC in air (a) and blood (b) conditions.

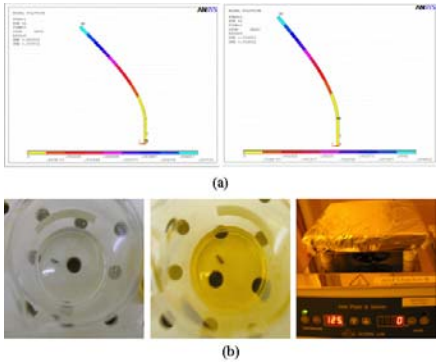

Figure 3. Figure 3. Simulation results of a IPMC coated SU-8 film (a) and fundamental experiment for MEMS technology application (b).

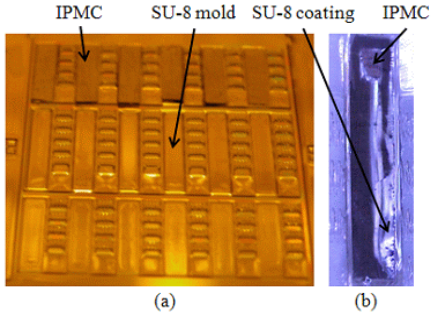

Figure 4. Figure 4. Optical images of a fabricated IPMC in SU-8 mold (a) and IPMC component (b).