Conducting Polymer Actuator in Open-Close movement and Its Application to Micro Pump

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The most outstanding feature of conducting polymer is drastic enhancement of electroconductivity upon oxidation and reduction. The conducting polymers can be utilized as a semiconductor device such as light emitting diodes, solar cells and transistors as well as metallic conductors. On the other hand, upon oxidization and reduction, the conducting polymers change physical properties as swelling or shrinking. The variation of the dimension is induced by an electrochemical cycle, which is called electrochemomechanical deformation (ECMD) and can be utilized as a soft actuator and artificial muscles. Many studies on conducting polymer soft actuators for conducting polymer polyaniline[1], polythiophene[2] and polypyrrole[3] have been performed so far. Recently, various shapes of conducting polymer soft actuators attract the attention of researchers. Hara et al[4] developed a polypyrrole-metal coil composite actuator and PPy-zigzag metal wire composite actuator. Moreover, Wu et al[5] developed a soft actuator with the structure of Tube In Tube Actuator Node for micro pumps. In our study, the authors have developed a soft actuator that performs open-close movement by using a conducting polymer soft actuator of a bimorph structure with polypyrrole. Furthermore, we have built up a micro pump with the above-mentioned soft actuator as a driving source.

Figure 1 shows soft actuator in which bimorph structures with anion-driven layers of PPy.PPS and cation-driven layers of PPy.DBS are connected and cation-driven layers arranged in face-to-face relation. Moreover, the size of the soft actuatore is 30*28 [mm^2] and it have 27 slits in the interval of 1 [mm]. The soft actuators were driven in a NaCl water solution of 1.0 [mol/l]. Figure 2 shows open-close movement of the soft actuator. For applied voltage, sinusoidal waves were given in the range of -1.2[V] to 1.0[V] and its frequency was 0.0025[Hz]. The soft actuator opened in oxidations and closed completely in reductions. Moreover, the soft actuator performs optimum open-close movement when the ratio of single layer structures and bimorph structures is 1:2. Figure 3 shows the pressure-oscillating volume characteristics of a micro pump using a conducting polymer soft actuator as a driving source. Its oscillating volume is 2.2 ~ 28.3 [μl/min] and equivalent oscillating volume was obtained even from glycerine, whose viscosity is 140 times as high as that of water.

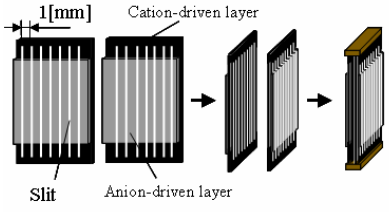

Fig. 1 Preparation of actuator

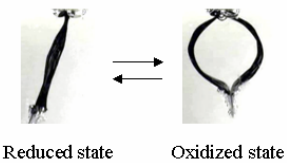

Fig. 2 Open-close movement

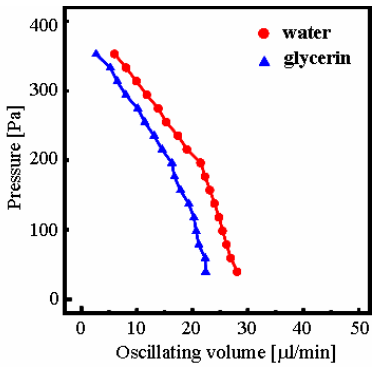

Fig. 3 P-OV plot

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