ELECTROMECHANICAL POLYMER ACTUATORS BASED ON IONIC-LIQUID GELS CONTAINING DISPERSED NANO-CARBON MATERIALS

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Recently, much attention has been focused on soft materials that can directly transform electrical energy into mechanical work, because they allow a wide range of applications including robotics, tactile and optical display, prosthetic devices, medical devices, micro-electromechanical systems and so forth[1]. Especially, electromechanical polymer actuators, which can work quickly and softly driven by low voltage, are very useful, since they can be used as artificial muscle-like actuators for various bio-medical and human affinity applications. In a previous paper [2], we reported the first dry actuator that can be fabricated simply by layer-by-layer casting, using 'bucky gel', a gelatinous room-temperature ionic liquid containing single-walled carbon nanotubes (SWNTs).

The bucky-gel actuator has a structure composed of ionic-liquid polymer gel sandwiched by two polymer-supported bucky-gel electrodes. The actuators show a bending response when applying low voltage between two electrodes, which should be caused by the double layer charging on the carbon nanotube in the bucky- gel electrode. (See Fig. 1).

It ie well-known that the SWNTs have extraordinary mechanical and electrochemical properties. Due to these properties, the SWNTs are promising as an electrochemical actuator material based on the double-layer electro-static mechanism which was firstly proposed by Baughman et al [3]. However, one major drawback is that the SWNTs are hard to process due to their poor dispersibility. On the contrary, we reported that the bucky-gel electrode layer has large electric double layer capacitance, since fine bundles of SWNTs dispersed in the bucky-gel electrode layer by a possible imizadolium cation- πinteraction on the SWNTs surface [4] have large effective electrode area, which gives the large actuation. Ionic liquids (ILs) are non-volatile and characterized by their high ionic conductivities and wide potential windows, which are advantageous for rapid responses in actuation and high electrochemical stabilities of the components, respectively.

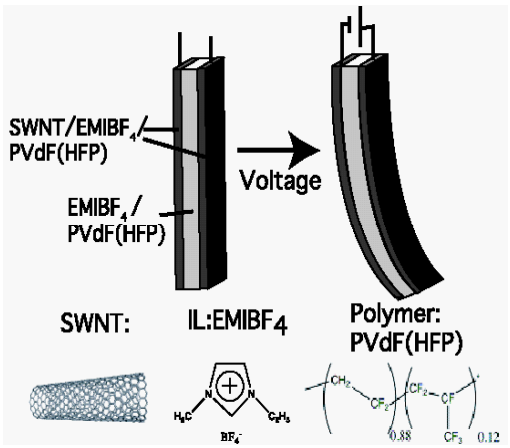

Fig.1 Schematic representation of the structure of the actuator.

We have developed the performance of the bucky-gel actuator by optimizing the preparing condition of the bucky-gel actuator and the internal ionic liquids on the basis of the double-layer charging model. Also, we have developed the actuator composed of the electrodes including ionic-liquid gels containing dispersed nano-carbon materials other than SWNTs and investigated the effect on the performance of the actuation. Some of the recent results will be presented and discussed.

References

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