5th International Conference on Materials and Reliability
Jeju, Korea, Nov. 27-29, 2019

Deformation characteristics of hydrogen storage type IPMC actuator

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1. Introduction

The IPMC actuator (Ionic Polymer Metal Composite: IPMC) is a composite in which electrodes are bonded to both sides of an ion-conductive polymer. By applying a voltage between the electrodes in an aqueous solution, internal hydrated cations (counter ions) move to the cathode side. As a result, unbalance of volume occurs in both poles, and bending motion is shown as in Figure 1. The IPMC actuator is characterized by being lightweight, flexible, driven with a low voltage (1 to 3 V), easily miniaturized, and expected to be used for artificial muscles and small robots. Conventionally, gold and platinum are used as electrodes, but these are expensive and difficult to plate. So, in this research, I used palladium which is cheap and easy to plate as an electrode.

2. The purpose of this study

When the manufactured IPMC using palladium was driven, irregular bending was observed. So, I thought that this IPMC have deformation other than bending by internal ion move. When the IPMC is driven in water, water electrolysis occurs and hydrogen is generated at the cathode. Furthermore, palladium is a hydrogen storage alloy and absorbs hydrogen to cause expansion [1]. From this, as shown in Fig. 2, it is considered that the bending by hydrogen storage occurs in this IPMC, in addition to the bending by internal ion move. In this study, we investigate the ratio of these two types of bending and clarify the deformation characteristics of hydrogen storage type IPMC.

3. Experiment to measure tip displacement

A hydrogen storage type IPMC was fabricated by plating of palladium on the surface of the Nafion film. Since this film have ionic groups, hydrogen storage type IPMC causes both of the above-mentioned bending. Similarly, a vinyl chloride specimen was manufactured by plating palladium on the surface of vinyl chloride. Since vinyl chloride does not have an ionic group, vinyl chloride specimens only bening by hydrogen storage. With two specimens, The tip displacement was measured by applying a voltage of 2 V for 8 seconds.

The tip displacement obtained from the experiment is shown in Fig.3. The tip displacement of the vinyl chloride specimen was adjusted in thickness and Young's modulus to the tip displacement by hydrogen storage in IPMC. The ratio of bending of hydrogen storage type IPMC was found to be 44% for internal ion move and 56% for hydrogen storage.

4. Conclusion

I manufactured IPMC using palladium which is inexpensive and easy to plate. This IPMC has two bends, The ratio of bending of hydrogen storage type IPMC was found to be 44% for internal ion move and 56% for hydrogen storage.

References

[1] Michihiko Nagumo,Fundamentals of Hydorogen Embrirrlement, Uchidarokakuho ,(2008)

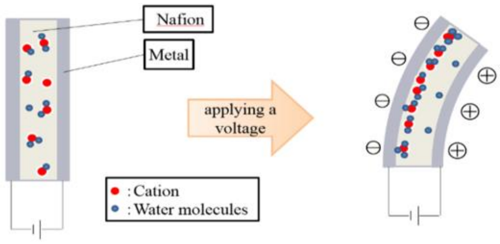

Fig.1 Driving principle of IPMC

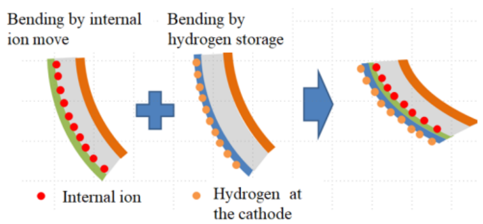

Fig.2 Two types of bending of hydrogen storage type IPMC

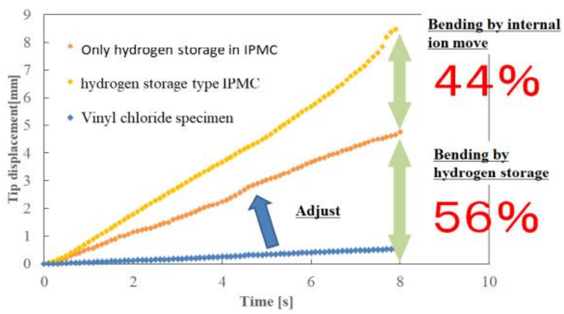

Fig.3 Experiment to measure tip displacement