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Structure Change of Iodine-treated Poly(vinyl alcohol) by Swelling

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1 Introduction

We have developed an iodine-treated poly(vinyl alcohol) (I-PVA) having extraordinarily large vapor-induced deswelling stress reaching 59 MPa, extremely large volumetric and gravimetric energy densities reaching 1.3×10^6 J m^{-3} and 9.6×10^2 J kg^{-1}, respectively, and an elastic modulus of a few GPa [1]. The high performance of the I-PVA can be demonstrated by a jump of a film on a plate wiped with a solvent-wetted cloth. In the present study, it was intended to investigate the structure change of the I-PVA due to swelling.

2 Experiment

The starting poly(vinyl alcohol) (PVA) films were prepared by dissolving a PVA powder with a polymerization degree of 900–1100 and a saponification degree of 86–90 % in distilled water at 90 °C, casting the solution and drying the films at room temperature for 48 hours. The starting PVA films were exposed to saturated iodine vapor by placing them into a glass vessel together with an iodine powder, depressurizing the vessel for 30 min and heating the sealed vessel at 100 °C for 24 hours. In order to remove iodine deposited on the surface, the iodine-treated PVA films were taken out from the vessel after depressurization at 100 °C for 1 hour and washed in methanol at 40 °C for 24 hours.

The experimental set-up as shown in Fig. 1 will be used for the measurement of structure change of I-PAV by swelling.

3 Results and Discussion

When the I-PVA film was placed on an alumina plate wiped with a methanol-wetted cloth, the film bent into a convex downward shape. By turning the film upside down, it jumped spontaneously as shown in Fig. 2. The mechanism for jumping is considered as follows: After turning the film upside down, swelling and deswelling of the film with the methanol vapor occurred at the surface facing the plate and the opposite surface, respectively. The film shape began to change from convex upward to convex downward, which did not proceed gradually in the order of convex upward, flat and then convex downward shapes but occurred suddenly in a manner of buckling without ever assuming a flat shape. When the central part of the film changed from convex upward to convex downward, this part slapped the plate and the film jumped.

We are planning to perform X-ray scattering measurements to detect structure change when the I-PVA film is exposed to methanol vapor.

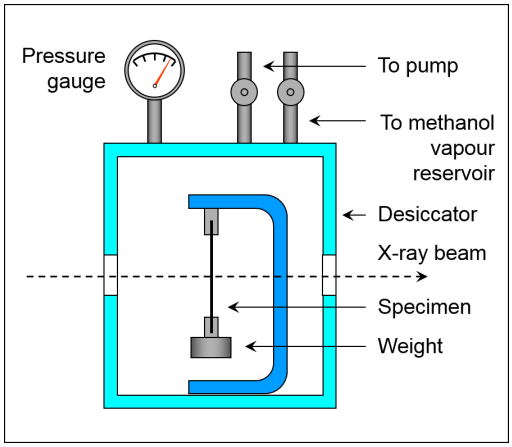

Fig. 1: Experimental set-up for the measurement of structure change of I-PVA by swelling.

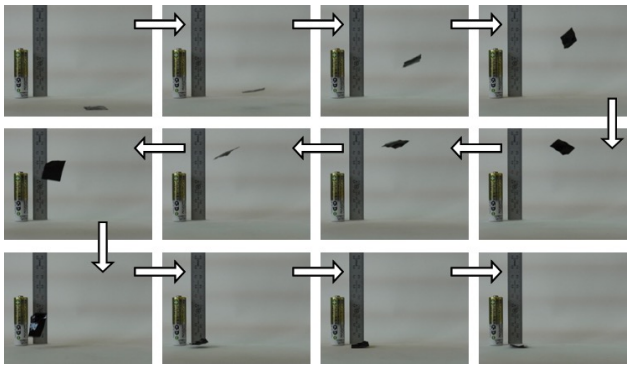

Fig. 2: Photographs of the I-PVA film when it jumped on an plate wiped with a methanol-wetted cloth [1].

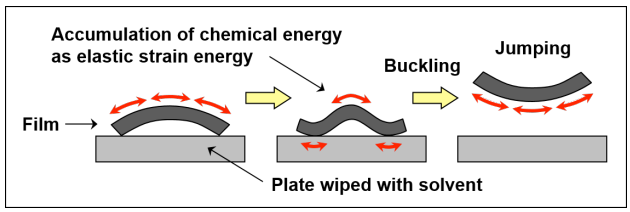

Fig. 3: Mechanism for jumping where arrows represent relative expansion at one side of the film compared to another side. [1].

References

[1] T. Takamura, K. Nozawa, Y. Sugimoto, M. Shioya, *J. Polym. Sci. B Polym. Phys.*, **52**, 1357 (2014).

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