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A study on the development of the durable polymer heart valve prosthesis

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1. INTRODUCTION

Since 1950's, various kinds of prosthetic heart valves (PHV) have been introduced and after the first success of the prosthetic heart valve replacement of the caged ball type PHV, some kinds of them have been used clinically and commercially available. All of these clinically using PHVs are either mechanical or tissue valve. Recently, there have been many efforts to develope a PHV by using inexpensive polymeric materials. But there are not any polymer heart valve that can be used clinically.

One of the main obstacles in the developement of clinically usable polymer heart valve is low durability of polymeric materials. Durability problem of polymeric materials is not only limited to polymer heart valve but also a significant problem in the field of artificial heart sac.

Polyurethane is widely used in artificial organs and is relatively durable than the other elastic polymers. But it is not durable enough to accept as a material for the PHV developement.

In this study, a woven fabric were introduced to improve the durability of polyurethane. Durability of this polyurethane composites was tested and compared to that of pure polyurethane.

The testing specimens were cut from the polyurethane sheet to the proper size. Dimension of the specimens are given in Fig.1. After being manufactured, the specimens were stored in a vacuum desiccator with silica at room temperature.

2. EXPERIMENTAL PROCEDURE

2.1. Materials

The materials selected for this experiment were as follows:

Commercially available plane fabric and DOW chemical, Hydroxyl end group, PELLETHANE 2363-80AE were used. Solvent used for the polyurethane was DMAC(N-N dimethylacet amide).

2.2. Sample Preparation

20%(weight percent) polyuretha/DMAC solution was used to make polyurethane film. Solution was prepared and degassed under vacuum. The solution was then poured with great care to avoid trapping further air bubbles, into the mold, and placed in a drying oven, and dried at 40 C for 3 days.

2.3. Fatigue Procedure

The specimens were divided into four groups,

one for control and the others for testing. The three testing groups were placed on fatigue machine and subjected to fatigue cycles. Number of the fatigue cycles were 10 thousand, 50 thousand, 100 thousand.

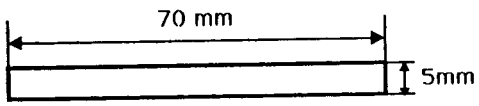

Fig.1 Dimension of Test Specimen

2.4. Mechanical Testing

Every specimen was subjected to the tensile test according to ASTM D412.

The load versus strain, modulus and load at failed were recorded.

3. RESULTS AND DISCUSSION

A typical shape of the stress-strain curves are as follows.

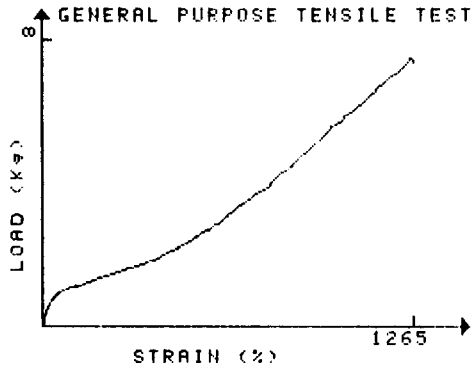

Fig2. Stress-Strain Curve for Pure-PU

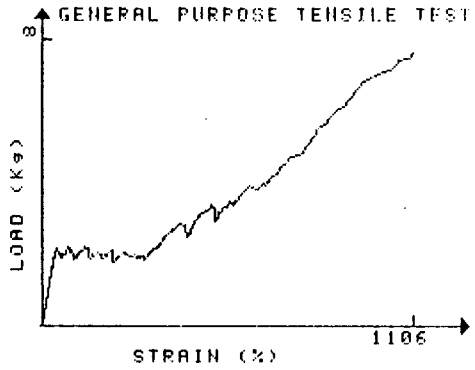

Fig.3 Stress-Strain Curve for Composite PU

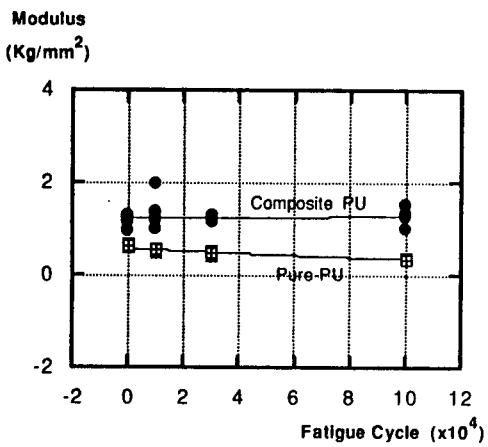

Fig. 4 Modulus of fatigued specimens

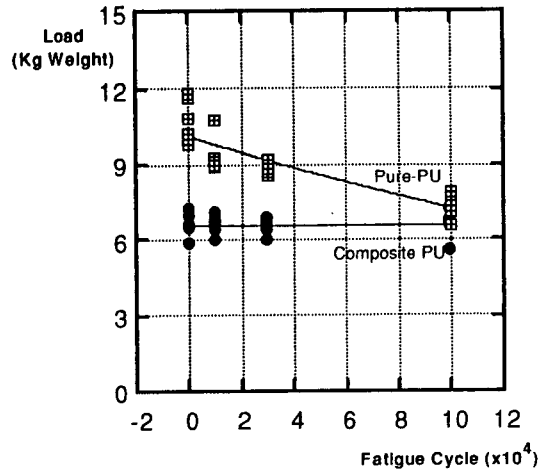

Fig. 5 Breaking Strength of fatigued specimens

As shown in the figure, failure mode of composite polyurethane is more complex than that of pure polyurethane. It may be caused by the step-by-step failure mode of composite polyurethane. This property would be advantageous to failure resistance. The steeper initial slope of the stress-strain curve of composite polyurethane seems to be caused by mechanical anisotropicity of reinforcing fibers.

The modulus and breaking strength of the control and fatigued specimens are as follows.

The modulus and breaking strain of the pure pu were decreased with load cycle. But those of composite pu were not changed after 100thousand cycle. It means that the durability of composite pu are better than the pure pu.

4. REFERENCE

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