Modern Applied Science

www.ccsenet.org/journal.html

Vol. 3, No. 3

March 2009

Performance Improvement of Weaving and Penetrability for 4mm Hollow Fabric of PHAs

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Abstract

This article introduces the advantages of new material PHAs (Polyhydroxyalkanoates) and its application in the medical domain, expatiates on the weaving method and machining technology of weaving the tube blank of 4mm artificial blood vessel by this material, and the measures to improve the penetrability according to the porosity.

Keywords: PHAs, Hollow fabric, Penetrability

PHAs is a sort of new macromolecule material arisen in recent years, and it possesses not only the materialized character of synthetic plastic, but the biodegradability, bio-compatibility, optical activity and piezoelectricity which are not possessed by synthetic plastic and many excellent performances such as large proportion of reproducible materials, low oxygen permeability, anti-ultraviolet radiation and anticoagulation, so it has wider application foreground in many domains such as textile, medicine, agriculture, food packaging and electron (Zhu, 2003, p.61-64 & Yang, 2005, p.1015-1021).

PHAs can be used as the implant of histology for animal and human being, and it can be made as the bracket of some organizations to implant into human body, and it can be made as the bone nail and bone stick in the orthopedic operation to fix the framework material. It has strengthening function, and it coarse surface could promote the growth of Human Tissues, and its holes could be used to penetrate and exchange. When new tissue forms, PHAs will gradually decompose, the results of decomposition could be absorbed by human body and would not produce bad reaction (Jiao, 2003, p.15-20).

1. Materials and apparatuses

1.1 Materials

PHAs filament includes the chip made by Tsinghua University and the spinning made by Tianjin Polytechnic University. Because PHAs spinning technology is not mature, so the diameter differences are large but the plasticity distortion is very good. The parameter means include the breaking strength is 286.2cN, the breaking tension if 4.5cN/T, the extension rate is 47.40%, the breaking power is 258.8mJ, and the average diameter is 0.25mm.

1.2 Apparatuses

The weaving adopts the WCS-03 computer sample weaving machine, and the long silk is tested by HD021 electric single yarn strength meter (made by Jiangsu Nantong Hongda Experiment Instruments CO., LTD).

2. Design

Use the method of "staving-weaving-reverting", first stave the 3D tube preform to make it a sort of plane fabric with multiple layers structure, then wave this fabric by the weaving principle of multiple layers fabric, and finally revert the multiple layers fabric to the solid shape of tube preform (Yi, 2002, p.7-8).

2.1 Confirmation of tube blank basic weave

The tube weave should select same weave as the basic weave of surface layer and inner layer. Under the premise to fulfill the requirement of fabric, the basic weaves should possibly select simple weaves such as plain weave, twill weave and satin weave to simplify the machining work, for example, if the weave is required to be successive on the folded place of the fabric, so the weave which latitudinal S is constant should be adopted as the basic weave, and the total amount of longitude yarn is fixed, and it can not increase or reduce optionally (Zhu, 2004, p.5-7). Therefore, two sorts of weave such as 2/2 twill and 1/1 plain are adopted.

2.2 Confirmation of total longitude yarn amount

First, confirm the tube diameter R of the fabric, compute the tube breadth W according to the tube diameter, and compute the total longitude yarns M_J on the upper and lower layers according the tube breadth.

$$W = \pi \times R$$

$$M_J = 2 \times W \times P_J = \pi \times D \times P_J \quad (1)$$

To keep the continuity of fabric brim weave, the total longitude amount through computation must be modified by following formula.

$$M_j = R_J \times Z \pm S_w \quad (2)$$

Where, R_J is the longitude circle amount of the basic weave, Z is the circle amount of the inner layer and the surface layer of the basic weave, S is the latitude amount of the basic weave (coefficient-constant), and when the latitude direction is from right to left, S is positive sign, and when the latitude direction is from left to right, S is negative sign (Zhu, 2004, p.5-7).

3. Weaving

3.1 Confirmation of parameters

According to formula (1) and (2), compute and adjust the parameters, the longitude yarn amount takes 47, the reed number is 80, 8 penetrates, so the actual tube blank diameter is little bigger than the design diameter, and it is convenient to be treated.

3.2 Machining figure

Figure 1 is the machining figure of 2/2 twill weave, and it only needs modify the twill figure when weaving 1/1 plain weave (Cai, 1979, P.124-127).

4. Results and discussion

4.1 Practicality figure

In figure 2, the first part is the 2/2 twill part and the second part is the 1/1 plain weave (two longitude yarns are thick).

4.2 Performance analysis

From Table 1, two sorts of weaves have better porosity, and it offers advantageous conditions for the successive disposal.

Because the warp and weft yarns are interlaced each other, so the holes must exist on the surface of the fabric, and if the density of the fabric is not high, too large spacing among yarns will induce the effusion of blood when it is directly used in clinic, but too high density could not be achieved under certain conditions of materials and equipments (Zhao, 2002, p.2-22).

Therefore, the successive disposal method to the fabric could make it achieve proper penetrability. The successive disposal method could strengthen and densify the fabric to stabilize the structure, increase the density of the fabric, reduce the opening rate and prevent blood penetrability. And it can reduce the stress J on the seam place after implant to certain extent, make the blood vessel possess stronger anti-drawn ability and small avulsion transfer property, and improve the stress on the seam place and the anti-extrusion performance (Ling, 2003, p.49-52).

5. Conclusions

The method proved that it was feasible to weave the artificial blood vessel tube blank of 4mm by the machine, and the better penetrability effect could be achieved after disposal according to the porosity, and the study in the article was the helpful attempt for the production and improvement of the artificial blood vessel with the diameter less than 6mm.

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Table 1. The tightness of two sorts of weaves (Yao, 1990, P.492-494)

weave	Total tightness (%)	Longitude tightness (%)	Latitude tightness (%)	Longitude and latitude tightness proportion
2/2	98.9	98	43.6	2.2:1
1/1	96.2	90.5	60	2:1

Note: 2/2 weave: P_T= 392/10cm, P_w= 178/10cm, d_T= d_w= 0.25mm.

1/1 weave: P_T= 362/10cm, P_w= 240/10cm, d_T= d_w= 0.25mm.

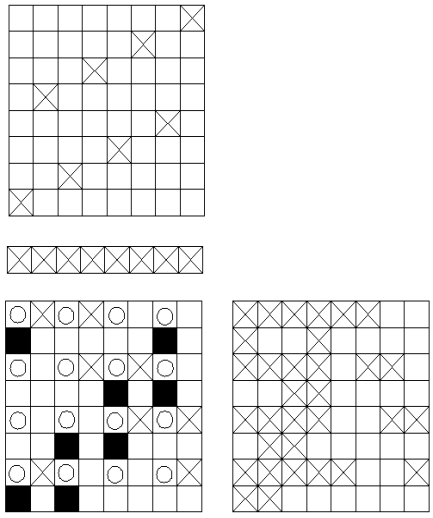

Figure 1. Machining Figure of 2/2 Twill Weave

Figure 2. The first part is the 2/2 twill part and the second part is the 1/1 plain weave (two longitude yarns are thick)