

# Development of Textile Scaffolds for Heart Valves

C. Fano<sup>1</sup>, M. Dauner<sup>1</sup>, M. Doser<sup>1</sup>, H. Planck<sup>1</sup>, B. Akra<sup>2</sup>

<sup>1</sup>Institute of Textile Technology and Process Engineering, Denkendorf, <sup>2</sup>Klinikum der Universität München, Herzchirurgische Klinik

## Introduction

- In 2007, about 21.000 heart valve prothesis were implanted in Germany.
- Conventional-valve-risks: Rejection, Calcification, Thrombosis.
- Aim: development of a physiological, synthetic valve without these adverse effects.

## Materials and Methods

- Manufacturing: a fiber spraying process, developed at ITV Denkendorf (Figure 1).

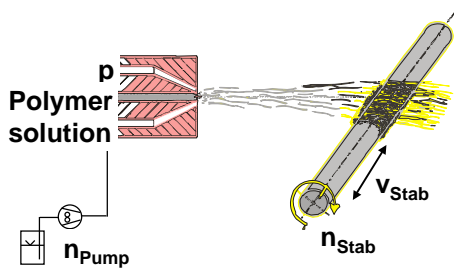


Figure 1: Fiber spraying process

- The semilunar valves are fixed inside the aortic root.
- The valve has the shape of a biological aortic valve (Figure 2).



Figure 2: Textile Heart valve

- Flow characteristics similar to natural valves and the prevention of blood cell damage are intended.
- The nonwoven matrix is seeded in vitro with human (autologous) endothelial cells to prevent the risks of rejection, thrombosis, and calcification after implantation.
- Characterization of the device:
  - pore volume
  - fiber finesses
  - plaque formation
  - surface traction
  - weight.

## Results

- Investigation on the effect of the following parameters on the properties of the heart valve (tensile strength, structure):
  - Traverse speed of rod / form ( $v_{Stab}$ )
  - Rod / form rotations ( $n_{Stab}$ )
  - Feed rate of the spinning pump ( $n_{Pumpe}$ )
  - Spraying air pressure ( $p$ ).
- The tensile strength ( $F$ ) has maxima in the range of slow and fast  $v_{Stab}$ . The fibers are finer, if  $v_{Stab}$  is very high.
- To prevent the formation of fiber ropes and to increase  $F$ , a high  $n_{Stab}$  is necessary.
- If  $n_{Pumpe}$  is reduced, the fibers become finer and the nonwoven will be more compact.
- $p$  has the strongest influence. A high  $p$  produces fine plaque-free fibers (Figure 3). Resulting in a stronger cross- linking within the Nonwovens, they increase  $F$ .

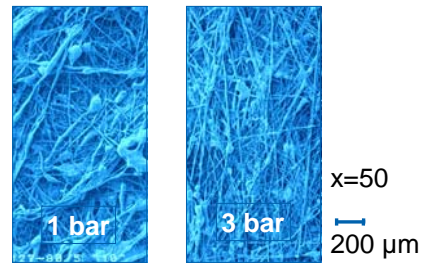


Figure 3: SEM- Image of an nonwoven sprayed with 1 and 3 bar

- The pore volume significantly increases, if  $n_{Stab}$  and  $p$  increase.

## Conclusion

- If the Nonwoven is produced with high  $p$ , low  $n_{Pumpe}$  and high  $n_{Stab}$  and  $v_{Stab}$ , fine fibers with a high tensile strength can be achieved. As a result very thin and flexible semilunar valves can be produced, which open and close very smoothly.
- The Grosshadern Hospital showed that the surface of both prothesis can be seeded with cells (Figure 4).

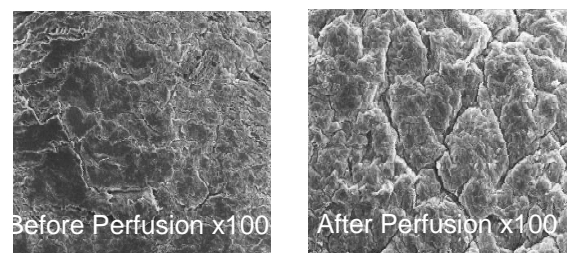


Figure 4: Cell Adhesion before and after perfusion