

Composite synthetic vascular prosthesis design

Citation for published version (APA):

Oijen, van, C., Vosse, van de, F. N., & Baaijens, F. P. T. (1999). *Composite synthetic vascular prosthesis design*. Poster session presented at Mate Poster Award 1999 : 4th Annual Poster Contest.

Document status and date:

Published: 01/01/1999

Document Version:

Publisher's PDF, also known as Version of Record (includes final page, issue and volume numbers)

Please check the document version of this publication:

- A submitted manuscript is the version of the article upon submission and before peer-review. There can be important differences between the submitted version and the official published version of record. People interested in the research are advised to contact the author for the final version of the publication, or visit the DOI to the publisher's website.
- The final author version and the galley proof are versions of the publication after peer review.
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Introduction

Bypass or replacement of diseased medium-sized arteries (coronary, femoral and carotid) is mostly performed using autologous veins. Clinical practice reveals that commercially available synthetic artery prostheses can be used only for arteries with large flow, small resistance and large diameter (> 10 mm). Failure of medium-sized and small (< 5 mm) synthetic prostheses is often contributed to a mechanical mismatch with the host artery [1], [2].

Objective

- development of a synthetic vascular prosthesis which is mechanically compatible with the host artery, based on an experimentally validated computational model

Methods

Mechanical characterisation

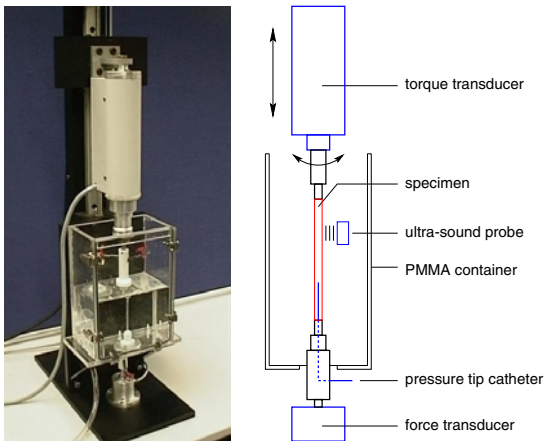


Figure 1: Experimental setup

Dynamic bi-axial tensile test

- axial extension \rightarrow longitudinal properties
- pressurization \rightarrow circumferential properties
- torsion \rightarrow shear properties
- dynamical loading \rightarrow viscoelastic properties

References:

- [1] HOW, T.V. AND GUIDOIN, R. AND YOUNG, S.K.: *Journal of Engineering in Medicine* 206, 62-71, 1992
 [2] HOFSTRA, L.: *Intimal hyperplasia in human vascular grafts*, PhD. Thesis, University of Maastricht, 1995

Prototype development

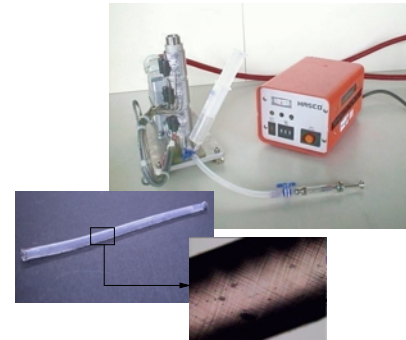


Figure 2: Fibre-reinforced hydrogel tube

Reactive Injection Molding

- viscoelastic matrix (hydrogel)
- non-linear elastic fibres (Lycra)
- optimized fibre layout

Computational

- geometrically non-linear (Updated Lagrange)
- physically non-linear (under construction)
- FEM

Results

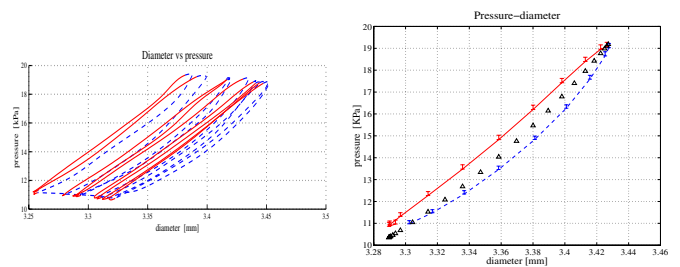


Figure 3: Pressure-diameter relation (left) of a human artery and the fit (Δ) on the averaged data (right)

Conclusion

Fibre reinforced hydrogel tubes show better results than existing prostheses, but are still mechanically incompatible. Extended measurements of natural coronary or femoral arteries are needed to decide whether the composite prostheses are able to mimic their dynamic mechanical behaviour.