

## Poly(ester-anhydride) fibres used as porogen in TE scaffolds

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### Customer need

Porous polymeric tissue engineering scaffolds of 3-dimensional structure have been prepared by various solvent casting/particulate leaching methods using different porogen additives. One of the most widely used methods involves compression moulding of a polymer salt mixture, followed by salt leaching. A drawback of the technique is achieving pore interconnectivity at low porogen (salt/sucrose) loadings, as many of the porogen particles may remain trapped. Another issue that is noteworthy is that the interconnection between the pores is smaller than the size of the pores. This may limit the propagation of cells from one pore to the other in certain applications. Generally the pore size and pore shape is determined by the leachable particles characteristics (size and shape).

The purpose of this study was to demonstrate the use of biodegradable polymer fibres in selective leaching resulting in predetermined pore structure. The polymer fibres were photo-cured methacrylated

poly(esteranhydrides) (PEAH). The advantage in the use of the fibres being the in situ porogenisation, predetermined pore network and pore sizes. Composites containing 30 vol-% of PEAH fibres were studied. The matrix material in this study was biodegradable, photo-curable methacrylated polyester precursor.

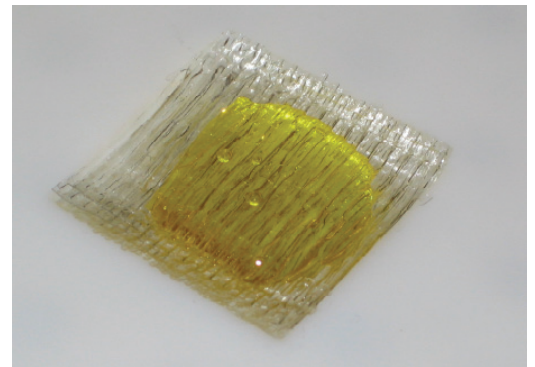


Figure 1: Starting PEAH sample.

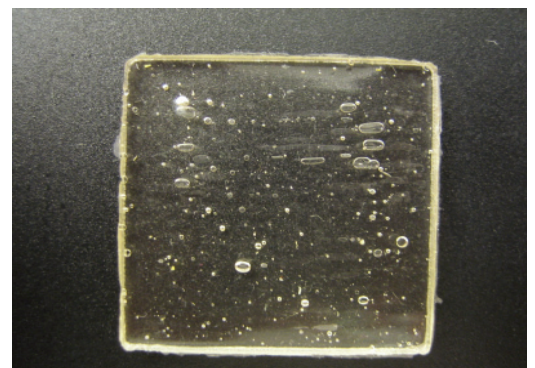


Figure 2: Sample after photo curing.

### Customer need

Analyzing the change in porosity to demonstrate the use of biodegradable polymer fibres in selective leaching resulting in predetermined pore structure.

### Materials and methods

SCANCO Medical  $\mu$ CT 40 scanner was used to produce the images and SCANCO evaluation software for determining porosity and fibre dimensions.

### Results

**Qualitative:** Visualization of the micro-architecture.

**Quantitative:** Porosity (vol %) and fibre dimensions.

### Materials and methods

PEAH fibres were prepared by the following polymerisation scheme: prepolymer was prepared by ring-opening polymerisation of  $\epsilon$ -caprolactone, Sn(II)2-ethylhexanoate was used as initiator and pentaerythritol as co-initiator resulting in star-shaped precursor. The prepolymer was further treated with succinic anhydride for conversion of the

hydroxyl group end functionality to carboxylic acid functionality. Methacrylic anhydride was used to obtain polyesteranhydride resin. Matrix material was polyester resin based on e-caprolactone precursor and methacrylic anhydride. Fibres were prepared by photo-curing PEAH resin onto spinning coil and using a Triad 2000 light curing unit. Composites were prepared by curing several oriented layers of fibres (mat or mesh) and matrix resin containing 2 wt-% camphorquinone in a Teflon mould. Cured plates were cut into 10mm x10mm x2mm samples for hydrolysis. Composites were studied in buffer solution for three weeks and characterized with optical microscope, scanning electron microscopy (SEM) and  $\mu$ CT40 (Scanco Medical, Switzerland).

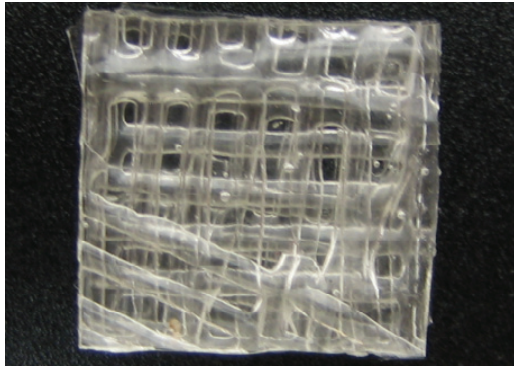


Figure 3: Sample after hydrolysis.

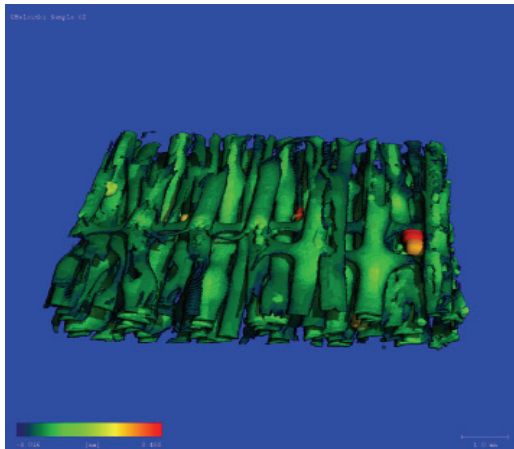


Figure 4: 3D CT Image of the pore structure

## Results of the analysis

Pores were formed within one week in hydrolysis. Water absorption into the composites increased steadily and was 34.2% ( $\pm 2.7\%$ ,  $n=3$ ) after one week; this corresponds to amount of water in the pores. Porosity estimated with  $\mu$ CT40 for cubic thickness was 29.9 vol.% for mat and 43.0 vol.% for mesh containing composites. Pore network was

determined by the dimensions of the fibres (500-850  $\mu\text{m} \times 100\mu\text{m}$ ).

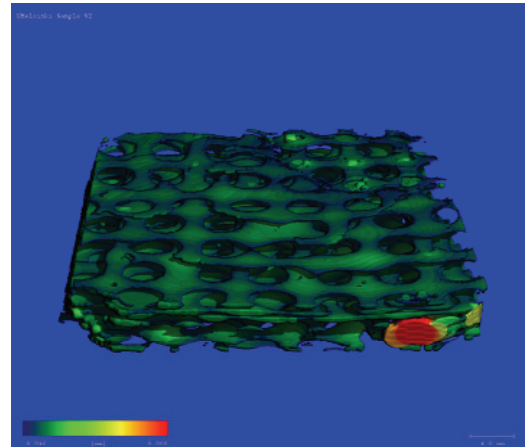


Figure 5: 3D CT Image of the pore structure

## Conclusions

- Labile PEAH fibres and meshes were successfully prepared by photo-cross linking, and used in composites as porogens
- Porous structures were obtained within 1 week hydrolysis and the pore structure and size was determined by the dimensions of the fibre porogens
- Pores formed were of uniform size and amount of porosity determined by the amount of fibres
- Room temperature cross linking would enable inclusion of sensitive active agents into the fibres and consequently fast release at the site

A further study to characterize the dissolution properties of the fibres containing bioactive glass and the optimization of the bioactivity is underway.

## References

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### SCANCO equipment

SCANCO Medical  $\mu$ CT 40 scanner

### SCANCO software

Measurement program incl. Scout View  
Evaluation program

- ✓ 3D Morphometric analysis
- ✓ Porosity

Visualization program