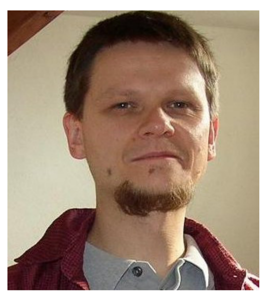
The Use of Electrospinning for Preparation of Biodegradable Polyester Nanofibres Combined with Bioglass® for Tissue Engineering



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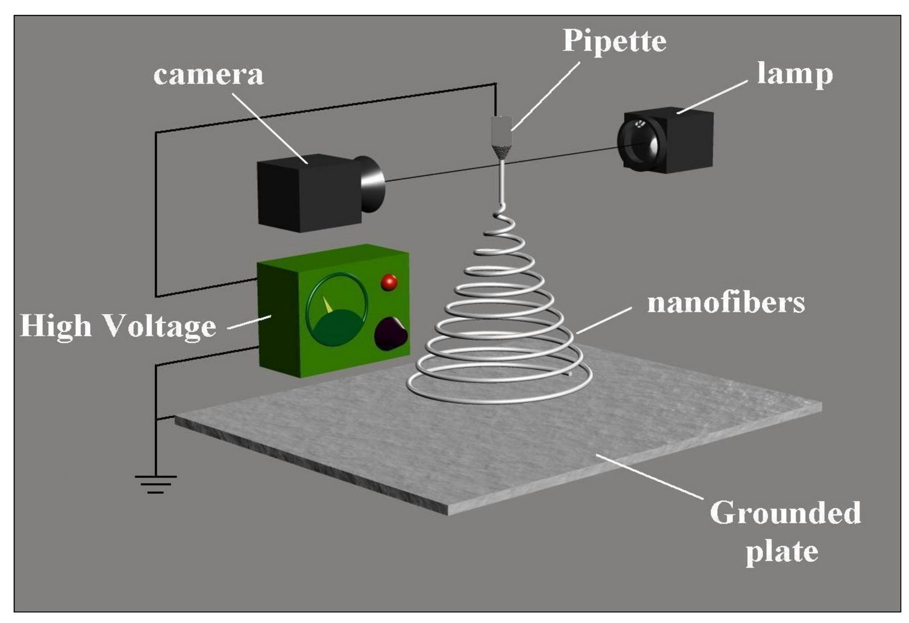
Introduction

- Modification of bioactive surfaces (Bioglass®) for tissue engineering applications was investigated
- Sintered Bioglass® based glass-ceramic pellets were coated with nanofibres of biodegradable materials to promote osteoblast cells adhesion and proliferation
- Polymer coated bioactive glass surfaces were further investigated in simulated body fluid (SBF) to assess their acelular bioactive behaviour
- Bioactive glass-ceramic pellets were fabricated using the same processing parameters optimised for fabrication of 3D scaffolds by the foam replica technique (Chen et al., 2006)
- Fibre meshes were prepared from poly(caprolactone), PCL, poly(3-hydroxybutyrate), P(3HB) and copolymer poly(3-hydroxybutyrate-co-hydroxyvalerate), PHBV, with the use of electrospinning method
- Electrospinning process was optimised to obtain materials of desired properties
- Electrospinning was observed by ultra-fast camera
- Materials were characterised by means of optical and Scanning Electron Microscopy (SEM)

ELECTROSPINNING OUTLINE

- Electrospinning is a modern and effective method of producing nanofibres
- The fibre is pulled out due to the electrostatic force between pipette and collector
- The fibre is created from a pendant droplet at the tip of the pipette when the electrostatic force overcomes surface tension
- The jet extends in a straight line for a certain distance and then bends and follows a looping and spiralling path
- In this process electrical forces elongate the jet thousands or even millions of times
- As a result 0.0003mm nanofibres are produced from polymer jets of 0.5mm in diameter

BASIC SETUP

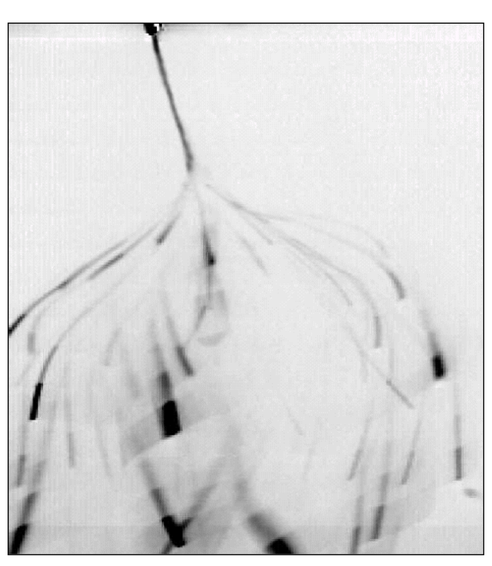


Schematic drawing of the electrospinning process

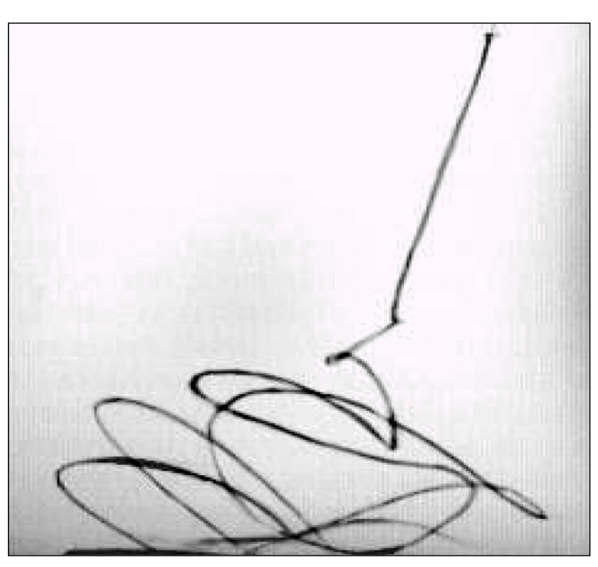
Basic equipment

- Syringe pump with polymer solution supply
- High voltage power supply (up to 30kV)
- Collector – Bioglass® pellets on thin glass substrate. Grounded copper mesh
- High speed camera (up to 40720 fps)
- Epi-fluorescence microscope
- SEM microscope

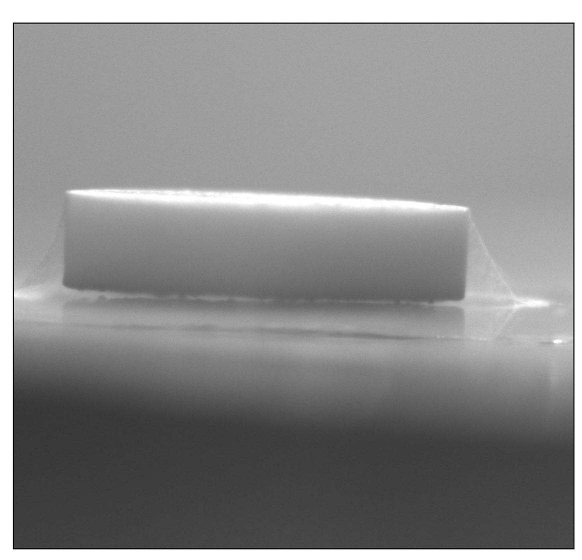
RESULTS



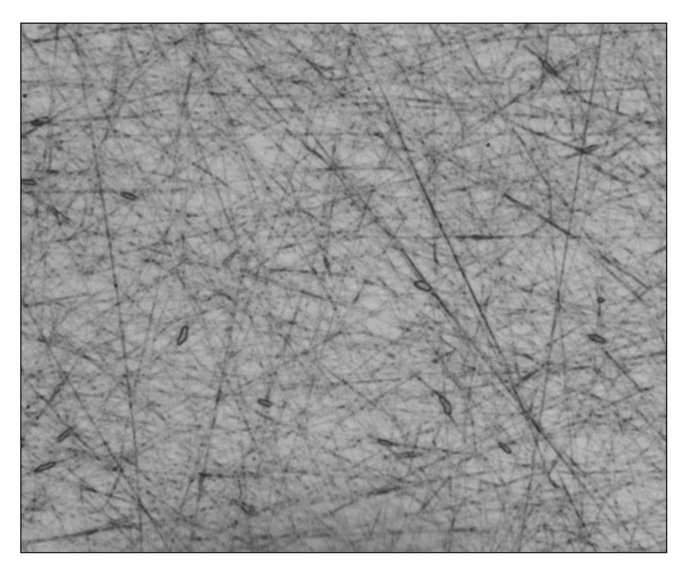
Electrospinning of PEO observed at 30 fps



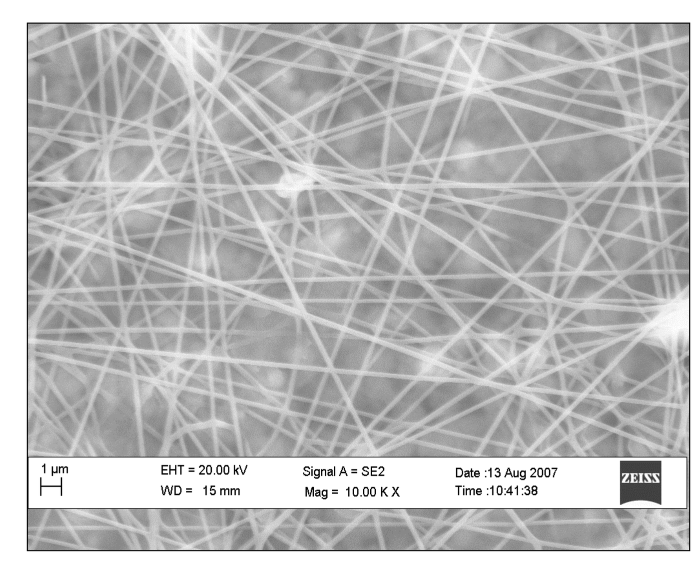
Electrospinning of PEO observed at 4500 fps



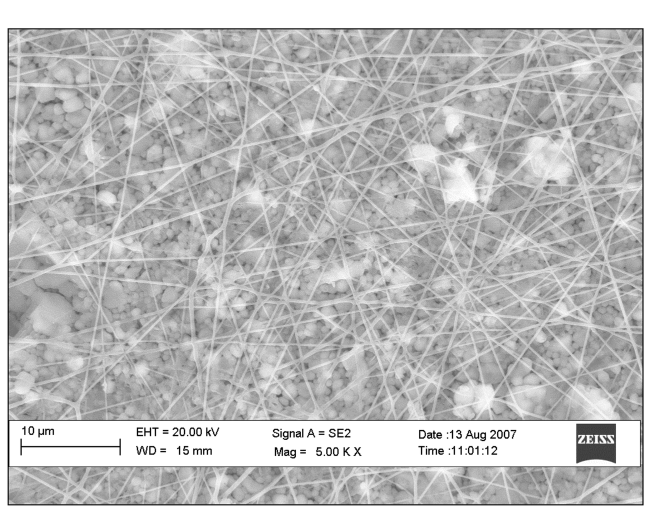
P(3HB) nanofibres captured in the reflected light on the Bioglass® pellet. Picture width: 6.9 mm



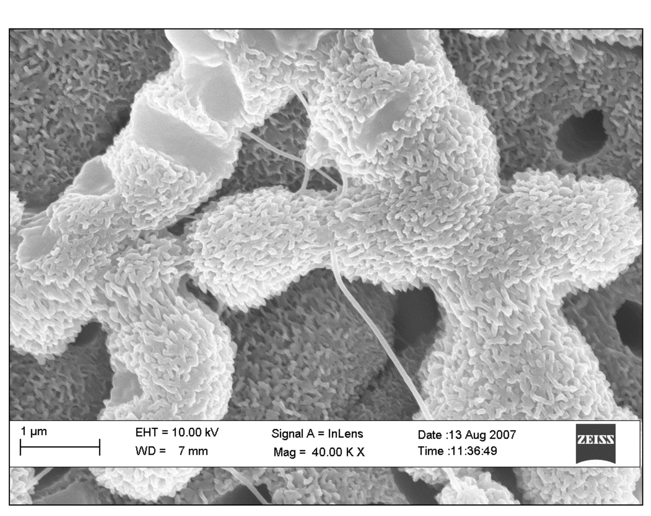
P(3HB) nanofibres observed in the optical microscope. Picture width: 180 μm



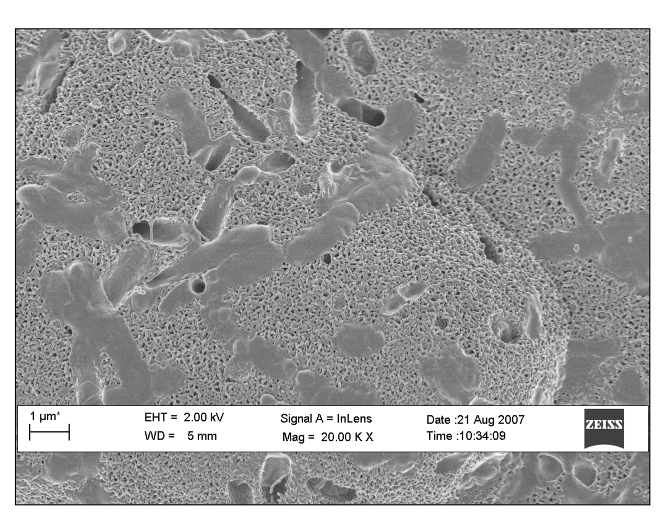
P(3HB) nanofibres on Bioglass® surface observed in the SEM



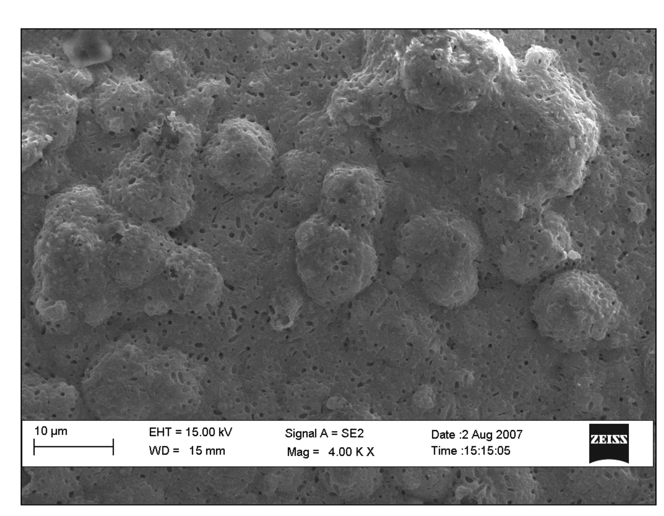
PHBV nanofibres on Bioglass® surface observed in the SEM



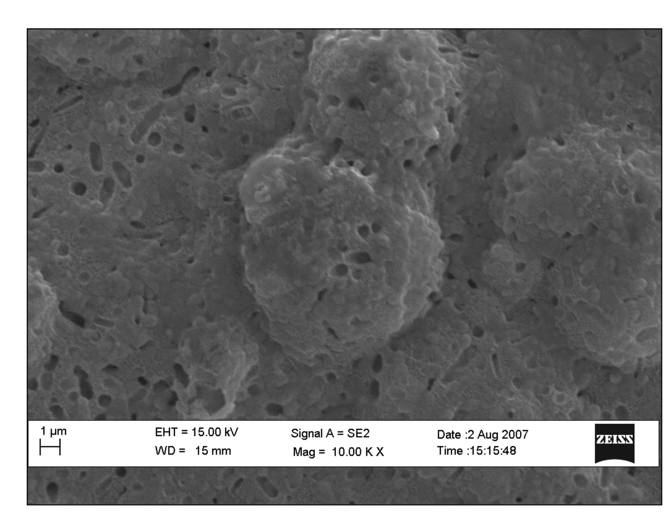
HA crystals formed on PHBV nanofibres and Bioglass® surface after 7 days of immersion in the SBF observed in the SEM



HA crystals formed on PHBV nanofibres and Bioglass® surface after 14 days of immersion in the SBF observed in the SEM



HA crystals formed on P(3HB) nanofibres and Bioglass® surface after 7 days of immersion in the SBF observed in the SEM



HA crystals formed on P(3HB) nanofibres and Bioglass® surface after 14 days immersion in the SBF observed in the SEM

Conclusions

- Nanofibres with limited amount of defects were obtained from P(3HB) and PHBV and composite material PCL/PEO
- Nanofibres were deposited on Bioglass® based glass-ceramic pellets
- Nanofibres made of PHBVP have completely hydrolysed after 14 days immersion in SBF, while that of P(3HB) hydrolysed before 7 days
- All nanofibre covered Bioglass® samples were highly bioactive and promoted hydroxyapatite crystals growth in SBF
- The ordered formation of hydroxyapatite crystals on nanofibres should enhance osteoblast cells attachment and proliferation

References, Acknowledgements

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http://fluid.ippt.gov.pl/nanofibres