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Poly(trimethylene carbonate) polymers and networks, Synthesis, properties and medical applications

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Poly(trimethylene carbonate) (PTMC) is an amorphous polymer with low glass transition, and is prepared by ring opening polymerization of the cyclic trimethylene carbonate (TMC) monomer. It can be copolymerized with other lactone monomers to yield materials with tuneable physical and chemical properties. Upon crosslinking flexible and elastic (co)polymer networks are obtained, with properties that resemble those of poly(dimethyl siloxane) (PDMS) rubber. Interestingly, the TMC monomer can be prepared from natural renewable resources using 1,3-propane diol that is obtained by fermentation of glucose.

While PTMC with number average molecular weights below 50000 g/mol are viscous or gummy materials with poor mechanical properties, high molecular weight linear PTMC is an amorphous, tough and flexible solid with a low glass transition temperature of -19 °C. The resistance to creep of the flexible polymer significantly increases when it is crosslinked. PTMC networks can be prepared by gamma-irradiation of linear high molecular weight PTMC polymer or by photo-crosslinking functionalized macromers based on TMC using UV-or visible light.

Materials based on PTMC are very useful in biomedical applications. Linear (co)polymers and (co)polymer networks prepared from TMC and D,L-lactide or e-caprolactone were shown to be compatible with a large number of cells and implantation experiments in small animals showed only a mild tissue response. PTMC based polymers and networks were found to degrade in the body by an enzymatic surface erosion mechanism, without the release of acidic degradation products. This makes these polymers very well-suited as a matrix in the preparation of biodegrade composite materials for bone tissue engineering and drug delivery.

Here we will present work on the synthesis and properties of PTMC polymers and networks, their processing into medical implants by conventional processes and advanced additive manufacturing methods and their characteristics in the presence of cells and upon implantation.

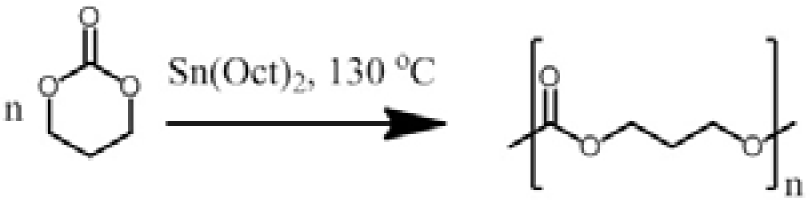

Figure 1: Ring-opening polymerization of trimethylene carbonate (TMC) using stannous octoate (Sn(Oct)2) as catalyst to obtain high molecular weight poly(trimethylene carbonate) (PTMC).

Biography

Prof. Dr. Dirk W. Grijpma is professor and head of the department of Biomaterials Science and Technology at the University of Twente. He also holds a part-time professorship in the Development and Clinical Application of Biodegradable Polymers at the University Medical Center Groningen. His expertise is in the synthesis, advanced processing and properties of (degradable) polymeric materials for use in medical devices, tissue engineering and in the delivery of relevant biologically active compounds. His research also includes the interaction of these materials and devices with cells and tissues. He is editorial board member of Biomaterials, Acta Biomaterialia, the Journal for Applied Biomaterials and Biomechanics, the Journal of Orthopedic Translation and the Journal of Medical Materials and Technologies. He was elected Fellow Biomaterials Science and Engineering (FBSE) in 2008. Professor Grijpma is (co)author of more than 235 refereed scientific publications and is (co)inventor on 24 international patent applications.

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