Poly-Ionic Liquids as New Hydrogel Materials: Synthesis, Characterization and Application

Bandomir J¹, Schulz A¹, Taguchi S², Petersen S³, Kragl U¹, Ohno H², Sternberg K³

¹Institute for Chemistry, University of Rostock, Germany

²Tokio University of Agriculture and Technology, Japan

³Institute for Biomedical Engineering, University of Rostock, Germany

jenny.bandomir@uni-rostock.de

Abstract: New hydrogel materials were successfully synthesized by polymerization of imidazolium-based ionic liquids. These materials were fully characterized to compare chemical and mechanical properties with alginate based gels. The synthesized hydrogels are currently under investigation *in vitro* to determine drug release behaviour of drug-coated balloons within a vessel-simulating flow-through cell.

Keywords: Hydrogels, ionic liquid-polymerization, drug release, tissue engineering

Introduction

Biocompatible polymers are widely used in pharmaceutical and medical applications as tissue engineering [1, 2]. One interesting implementation of these materials is the controlled drug release from local drug delivery (LDD)-systems, e.g. drug-eluting stents. The advantage of LDD is the direct application of therapeutic pharmacologic agent into a target tissue [3]. Generally, drug release behaviour of LDD-systems is studied *in vitro*. Here tissue engineering materials, e.g. calcium alginate, can be used as hydrogel compartment within a vessel-simulating flow-through cell [4]. Based on the insufficient long term stability of alginate based gels we focused our work on the synthesis, characterization and application of new hydrogel materials.

Methods

In this context we present an easy and efficient route to synthesize gels by polymerization of imidazolium-based ionic liquids (ILs) bearing a vinyl group with the cross-linker N,N'-methylendiacylamide (see Scheme 1) [5]. The radical polymerization was initiated with the help of tetramethylethylenediamine (TEMED) and ammonium persulfate (APS).

Results

We prepared a wide range of hydrogels using different imidazolium-salts [ViRIm]⁺X⁻ to investigate the influence of alkyl chain length and anion (R: Ethyl, *n*-Butyl, *n*-Octyl; X: Cl, Br, I, NO₃, BF₄, NTf₂, Acetate, Lactate). Important properties like the elasticity of these gels can be influenced by varying IL to crosslinker ratio. Furthermore, the mechanical characteristics will be described and compared to alginate gels. In addition, these hydrogels are able to incorporate

and deliver drugs like triamteren and paclitaxel. According to this they can be used as tissue engineering materials to create artificial vessel walls and as hydrogel compartment within a vessel-simulating flow-through cell for *in vitro* study of drug release. Examination of drug release and distribution from drug-coated balloons will be presented.

Scheme 1: Syntheses of poly-ionic liquids as new hydrogel materials with different anions and alkyl side chain

Discussion

Anions as well as alkyl chain length have an effect on the gelation. In case of lactate- and nitrate-containing imidazolium ILs no gelation process was observed. In contrast to the vinyl bearing imidazolium ILs we tried to generate hydrogels by polymerization of allyl-functionalized ILs without success. We synthesized hydrogels with promising characteristics like elasticity, long term stability as well as permeability. These acceptor compartments are used *in vitro* for drug delivery studies.

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