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High refractive index polysiloxane as Injectable, *in situ* curable accommodating intraocular lens

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ABSTRACT

Functionalised siloxane macromonomers, with properties designed for application as an injectable, *in situ* curable accommodating intraocular lens (A-IOL), were prepared via re-equilibration of a phenyl group-containing polysiloxane of very high molecular weight with octamethylcyclotetrasiloxane (D_4) and 2,4,6,8-tetra(n-propyl-3-methacrylate)-2,4,6,8-tetramethyl-cyclotetrasiloxane (D_4^{AM}) in toluene using trifluoromethanesulfonic acid as a catalyst. Hexaethyldisiloxane was used as an end group to control the molecular weight of the polymer. The generated polymers had a consistency suitable for injection into the empty lens capsule. The polymers contained a low ratio of polymerisable groups so that, in the presence of a photo-initiator, they could be cured on demand *in situ* within 5 min under irradiation of blue light to form an intraocular lens within the lens capsule. All resulting polysiloxane soft gels had a low elastic modulus and thus should be able to restore accommodation. The pre-cure viscosity and post-cure modulus of the generated polysiloxanes were controlled by the end group and D_4^{AM} concentrations respectively in the re-equilibration reactions. The refractive index could be precisely controlled by adjusting the aromatic ratio in the polymer to suit such application as an artificial lens. Lens stretching experiments with both human and non-human primate cadaver lenses of different ages refilled with polysiloxane polymers provided a significant increase in amplitude of accommodation (up to 4 D more than that of the respective natural lens). Both *in vitro* cytotoxicity study using L929 cell lines and *in vivo* biocompatibility study in rabbit models demonstrated the non-cytotoxicity and ocular biocompatibility of the polymer.

1. Introduction

Presbyopia, the loss of the eye's ability to change focus and provide clear vision for near objects (a function called "accommodation"), is the most common condition to affect the aged population [1,2]. To visualise objects, the natural crystalline lens and the cornea function together to focus light on the retina. To change focus for different viewing distances, the natural lens changes shape upon action of the ciliary muscles. However, the natural lens becomes stiffer with age resulting in a reduction of accommodation [3–5]. While reading glasses can bring near objects into focus, they have a fixed focal length and thus can provide clear focus only at a single distance. An ideal solution to presbyopia would be to restore the eye's ability to change focus continuously and dynamically. This may be achieved by replacing the hardened natural lens with a soft gel.

Cataract is one of the main causes of blindness, where opacification occurs in the natural crystalline lens [6,7]. The current standard procedure for the treatment of cataract involves removal

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