STABLE PEG-BASED POLYMER BRUSHES AS ANTI-FOULING LAYERS FOR BLOOD FILTRATION

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Introduction

Polyethylene glycol (PEG)-based brushes have been at the forefront of biological applications and nanomedicine due to their anti-fouling properties, low toxicity, wide availability, and use history in medicine and drug delivery materials [1]. In addition to the biocompatibility of such thin films, the macromolecules present a cost-effective possibility of functionalization, allowing the use of different monomers and architectural modifications according to the specific application [2].

In this work, we present a blood compatible noncharged PEG brushes for the application in a filtration membrane of an implantable kidney device (KIDNEW).

Methods

Poly(ethylene glycol) methyl ether methacrylate (PEGMA) brushes of different molecular weight were grafted in Silicon wafers by surface initiated activator regenerated by electron transfer atom transfer radical polymerization (ARGET-ATRP).

The optimization of synthesis conditions was conducted by approaching different strategies to anchor the brushes to the surfaces, concentration of monomer and catalyst, initiator, time of reaction and ligand [3]. The brushes' characterization was performed by ellipsometry and Atomic Force Microscopy (AFM).

Anti-fouling properties were probed in static and dynamic conditions for physiological concentrations of albumin. Quartz Crystal Microbalance with dissipation (QCM-D) allowed an insight on the protein resistance properties. Stability assay was performed by monitoring the thickness of the brushes after immersion of the coated silicon wafer in phosphate-buffered saline solutions over time.

Results

PEGMA brushes from 3 to 120 nm thicknesses were obtained. Static protein adsorption assay and QCM-D demonstrated the effectiveness in preventing adsorption of fresh and aged brushes. In addition, anchors were found to play an important role in the brushes' long-term stability. The investigations pointed to the degrafting in 90 days of brushes synthesized from 3-aminopropyl triethoxysilane (APTES). Increased stability was expected for poly(glycidyl methacrylate) (PGMA) macroinitiator based coatings, but complete degradation was also observed after 40 days. Interestingly, coupling the silane and the macroinitiator optimized the long-term stability, as depicted in Figure 1. The 2-bromo-2-methylpropionyl bromide (BMPB) and 2-bromo-2-methylpropionic acid (BMPA) initiators were also evaluated.

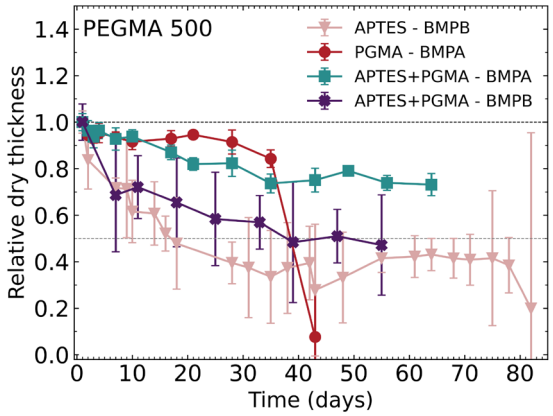

Figure 1:Stability assay for PEGMA500 brush: Relative dry thickness of the brushes after immersion in PBS for evaluation of surface anchoring and initiator.

Discussion

Protein adsorption experiments with fresh and a four-month aged brush with bovine serum albumin in concentrations between 1.0 and 7.0% revealed the remarkable anti-fouling properties of PEGMA brushes. Aiming the application in an implantable device, the long-term stability is a crucial parameter. The results evidenced strong hydrolysis process occurring in APTES surface-initiated brushes. The presence of an additional hydrophobic layer of polymer PGMA provides long-term stability by preventing the nucleophilic interaction with water [4]. The substitution of BMPB for BMPA also influenced the stability of the coatings. Altogether, the simple synthetic procedure, physicochemical characteristics, anti-fouling properties and stability of PEGMA brushes make these coatings attractive functional candidates to integrate a blood filtration device.

References

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