TAILOR-MADE POLYMER INTERFACES – SURFACES ON DEMAND

Stefan Helfert[a], Joschka Hellmeier[b], Eva Sevcsik [b], Robert Liska[a], Stefan Baudis[a]

[a]E163 - Institute of Applied Synthetic Chemistry - Polymer Chemistry and Technology at TU Wien
[b]E134 – Institute of Applied Physics – Biophysics at TU Wien

INTRODUCTION

The design and creation of particular interfaces between substrate surfaces and biomolecules became very attractive for research purposes and applications in the biomedical field[1]. The concept of building interfaces can be used for the manufacturing of biosensing platforms[2] (Figure 1), cell culturing, tissue engineering[3] and other fields, like cell research. In the last-mentioned area, applying the proper interface can yield profound information about the investigated species. A method for the design of such interfaces is the coating with functionalized polymer chains and covalently attached to a substrates surface, these organic linker molecules are then usually called polymer-brushes. To create such polymer interfaces, reversible addition-fragmentation chain transfer polymerization (RAFT) can be applied and the advantages of this polymerization technique are well defined polymers referring to the molecular weight or chain length distribution and a broad spectrum of compatible monomers[4] which gives the polymer chains particular properties. Custom end-groups can be introduced via application of the right chemical processes[5] and all these options make RAFT polymerization a powerful tool in the creation of custom-built complex architectures[6] with the desired chemical properties for biomedical applications[7].

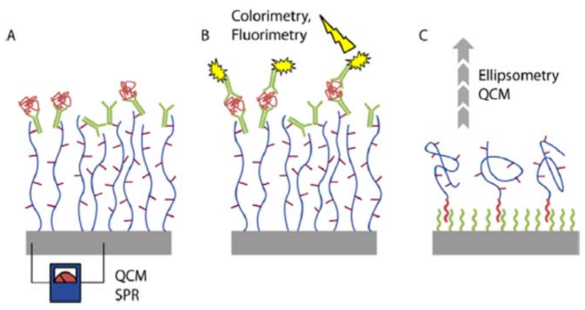

Figure 1: Biosensing platforms as an example of using polymer brushes[1]

OBJECTIVE

The aim of this project is the generation and characterization of polymer brush coatings on substrates used for cell interaction studies and tissue engineering. By application of grafting-from RAFT polymerization, 2D nano-architectures will be implemented, and in combination with photo-polymerization techniques even 3D architectures will be realized. In addition, the chemical properties of the polymer brushes will be tuned by variation of the used monomer, and the end-group functionality is easily customized via simple chemical reactions with potential for biofunctionalization (Figure 2).

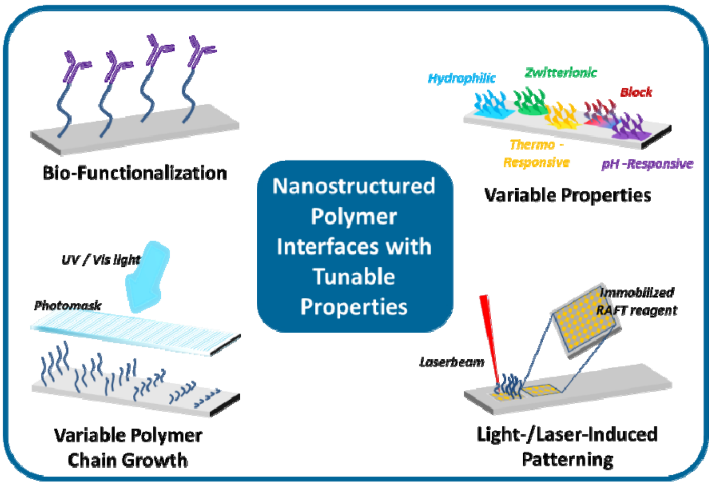

Figure 2: Potential of polymer brush coatings prepared by grafting-from RAFT polymerization

RESULTS AND DISCUSSION

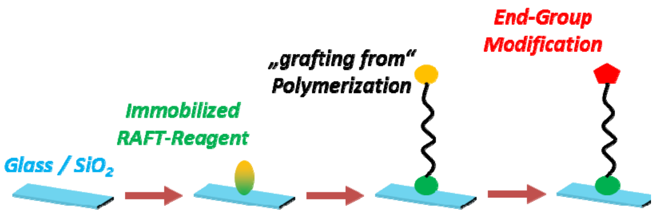

Figure 3: Step-by-step strategy for the preparation of RAFT polymer brush coatings on silicon oxide substrates

The main strategy (Figure 3) involves the immobilization of a RAFT reagent on the surface, by covalent bonding. From this point a monomer is chosen to introduce the chemical properties, such as hydrophilicity, thermo-responsivity or zwitterionicity. To find the right chemical identity of such polymer brush coatings is still challenging, for applications in the presence of cells and especially the study of their interaction with such interfaces, since the coating should mimic the extracellular matrix. First results on silicon oxide substrates (Silicon wafers, glass) were achieved by the application of a trithiocarbonyl based RAFT reagent in combination with N-acryloylmorpholine (NAM), a hydrophilic monomer. Therefore, the substrate was amino-functionalized via chemical vapor deposition in step 1 and the RAFT reagent was covalently attached via N-hydroxysuccimide coupling in step 2. Most important, the grafting-from RAFT polymerization of NAM in step 3 and the end group formation to a thiol group in step 4. The polymerization step was performed via thermal initiation but also the first successful results for photoinitiated systems were achieved. All these functionalization processes were monitored via water contact angle and ellipsometry and the changes are well recognizable in every step (Figure 4). Thiol-end-groups could be detected via labeling with fluorophores and analysis by total internal reflection fluorescence microscopy.

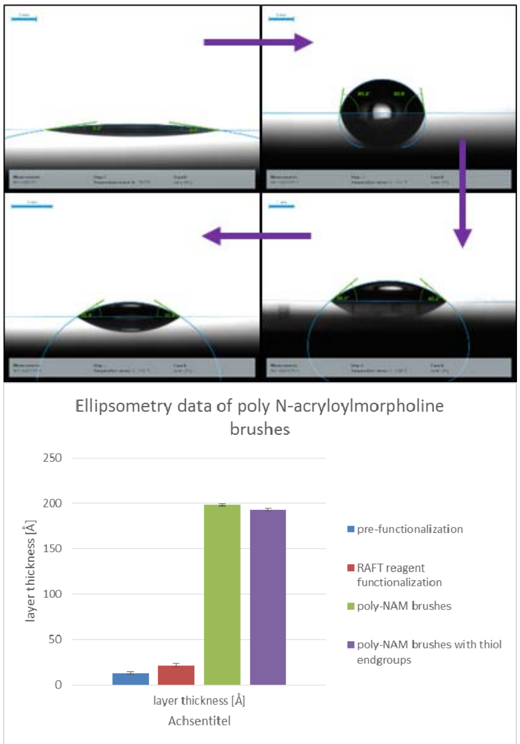

Figure 4: Contact angle measurements (top); Ellipsometry data (bottom) of a poly-NAM brush system

CONCLUSION

It was possible to apply grafting-from RAFT polymerization using NAM as monomer to coat silicon oxide substrates. By combination of the developed techniques, 2D materials with well defined architectures, chemical properties and biofunctionality for unique cell research can be established.

ACKNOLEDGEMENTS

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