

**A NOVEL METHOD FOR DESIGNING SURFACES TOWARDS BIOSYSTEMS**

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**INTRODUCTION:** Functional polymer monolayers are promising architectures for a variety of different applications especially in the life sciences mainly because the surface density of the functional groups can be driven to much higher values as it is possible for self-assembled monolayers of e.g. silanes that carry the same functional group. A technique towards such systems makes use of a monolayer of molecules that carry polymerisable groups. If these materials are added during a free radical polymerisation of other monomers the polymerisable groups at the surface are captured by the growing polymer chains and thin chemically anchored polymer monolayers are formed [1,2]. Despite this synthetic simplicity of this system, however, the general mechanism of the process was investigated in great detail and there is no report on the use of such systems for the construction of biologically relevant devices such as sensor or immuno assay systems.

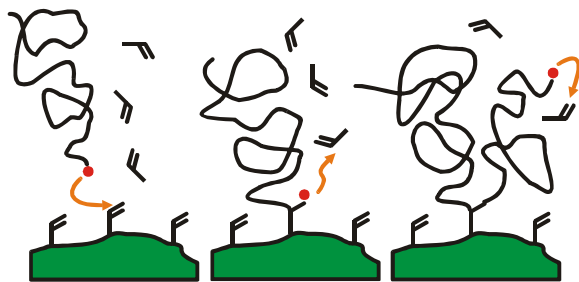


Fig. 1: 2-step mechanism of a radical copolymerisation with immobilised monomers.

**METHODS:** Basic experimental details can be obtained from the literature [3]. All silanisations were done in dry toluene under nitrogen using dry triethylamine as an acid scavenger and catalyst. Polymerisations were carried out in sealed vessels in a thermostat at 60°C. Prior to polymerisation oxygen traces of all monomer mixtures were carefully removed by at least 4 freeze-thaw cycles. The substrates carrying the polymer films were carefully extracted using a Soxhlet apparatus in order to remove any physically attached chains from the monolayers.

Film thicknesses were measured ellipsometrically (planar substrate) and the grafted amount was calculated from elementary analysis (porous substrate).

Activities of immobilised enzymes were derived from UV/vis spectrometre data and biomolecules (e.g. DNA, biotin) detected by fluorescence labelling.

**RESULTS & DISCUSSION:** A thorough investigation of this process showed that the variation of important polymerisation parameters

such as time, temperature and concentration of monomer and initiator allows for the preparation of polymer monolayers with a well-defined thickness and graft density of the polymers. Furthermore, we found that the overall process is largely insensitive to run-to-run variations of hard to control process variables (e.g. residual oxygen content during polymerisation; variation in graft density of immobilised polymerisable groups). This robustness of the technique and the radical polymerisation process used to deposit the monolayers make this method suitable for the tailoring of surface properties and for the incorporation of a wide variety of functional groups. We used (meth)acrylates that carried either N-hydroxysuccinimide ("active ester", NHS) or protected amino functions (phthalimide). The NHS moieties successfully bind enzymes (e.g. glucose oxidase) or DNA with terminal amino group. After deprotection with hydrazine the amino copolymerlayer reacts with isothiocyanate fluorescence labels or NHS-biotin.

Some examples of systems that are interesting for applications in the area of biomaterials are presented: Enzyme immobilisation for biotechnical reactors; reversible linkages via immobilised DNA strands; monolayers with covalently bound peptides or DNA on porous supports for analytical purposes. Furthermore, we show that biotinylation of the layers are promising candidates for biotin-streptavidin-assays

**REFERENCES:** <sup>1</sup>Hamann, K.; Laible, R. (1975) *Angew.Makromol. Chem.* **48**:97-133. <sup>2</sup>Chaimberg, M.; Cohen, Y. (1994) *AIChE Journal* **40**:294-310. <sup>3</sup>Bialk, M.; Prucker, O.; Rühe, J (2002) *Colloids and Surfaces A* **198**:543-

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