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Advances in Polymer Science

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Preface

These two volumes on surface-initiated polymerization deal with recent developments in the synthesis, characterization and properties of structurally and chemically defined polymer coatings on surfaces. Nearly all polymerization techniques that have been developed in solution have now been adapted for the surface-initiated polymerization (SIP). The reader will find all relevant techniques discussed in these volumes, such as free, controlled and living radical polymerization, living anionic and cationic polymerization (Rigoberto Advincula), and ring-opening metathesis polymerization (Michael Buchmeiser). Most of them are used to prepare so-called polymer brushes, a term describing strictly linear polymers that are densely grafted via one end to an interface. Such coatings display unique physical properties useful for a variety of applications. In particular, the high structural control of polymer brushes that can be realized by controlled or living polymerization techniques draws much attention. The contribution by Takeshi Fukuda et al. on high-density polymer brushes outlines the synthetic possibilities as well as the unique properties of polymer brushes. Such coatings will surely play an important role in innovative surface science and nanotechnology. The present contributions also reflect an ongoing trend: the development of defined heterogeneities on nearly any length scale. This can be realized by structured polymer coatings, gradients and control of the topography via the SIP reaction conditions. Jan Genzer's contribution on the preparation of polymer brush gradients is a good example. As it relates to defined structural variation and control of the macromolecular design of grafting polymers via SIP, I would like to point the reader to the contributions by Takehisa Matsuda on surface graft microachitectures or by David Bergbreiter discussing the synthesis and applications of hyperbranched polymers on surfaces.

Originally, the reviews were to be divided into, e.g., a *Synthesis*, *Properties* and *Application* section. Fortunately, this was not possible at all. Synthesizing a polymer coating by SIP is performing materials science from scratch. Introducing a slightly different monomer or changing the solvent will automatically alter the properties of the surface such as its wetting behavior, topography, elasticity, homogeneity, etc. It is exciting (and difficult!) to characterize the layers and find out why an altered reaction condition had such an impact upon the various layer properties. Thus, the researcher is immediately involved in various aspects of surface science and analytical challenges. This is reflected in all contributions. For example, Daniel Dyer discusses the fundamental and interesting aspect of the photoinitiated synthesis of polymer brushes. Of course,

the enormous advances in surface-sensitive characterization techniques developed for the investigation of self-assembled monolayers have provided the proper tools. However, as polymers are flexible, the investigation of the dynamic behavior of polymer coatings adds another dimension. The contribution by William Brittain on stimuli-responsive films gives an idea of the complex behavior of polymer brushes.

Besides the analytical techniques, the theoretical description of polymer brushes allows a deeper understanding of the complex dynamic behavior of polymers on surfaces and is useful for future developments. Here, Roland Netz gives – also for the non-expert – a very helpful theoretical background on the theoretical approaches for the description of neutral and charged polymer brushes.

The interest in polymer brushes and defined polymer coatings prepared via SIP is not at all restricted to the polymer community or the surface science community. The demand for tailored, functionalized and adaptive surfaces comes from a multitude of scientific branches and also from industry. Possible applications are already discussed in many of the contributions compiled here. Besides polymer science, surface chemistry and physics, they include catalysis, biomedical applications, microfluidics and nanotechnology. This creates a highly interdisciplinary, lively and fruitful environment.

Finally, I would like to thank all authors for their time and effort to make a state-of-the-art overview of surface-initiated polymerization possible. An edited book is only as good as its contributions and I had the privilege to compile contributions of the highest quality.

I am also grateful to Ms. Ulrike Kreusel and Dr. Marion Hertel from Springer for their professional help and patience.

Munich, January 2006 *Rainer Jordan*

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