Polymer and Biopolymer Brushes

Polymer and Biopolymer Brushes

for Materials Science and Biotechnology

Volume 1

Edited by

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This book is dedicated to our families.

Igal Szleifer also wants to dedicate this book to his coauthor Omar Azzaroni, who took over the bulk of the work after Prof. Szleifer suffered a stroke in October 2015. If not for Omar's work and dedication, this book would not have materialized. Igal is truly grateful.

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Preface

Polymers at interfaces is a field which has fascinated physicists and chemists now for nearly half a century, with respect to both basic and applied research. Polymer brushes refer to polymeric assemblies tethered at one end to a solid substrate either through covalent attachment or physical adsorption. At sufficiently high grafting density, due to repulsive interactions, the tethered chains stretch away from the surface into the solvent creating polymer brush structure. The conceptual origins of polymer brushes can be traced back to the 1950s, when it was discovered that flocculation could be prevented by grafting polymer chains onto colloidal particles. Over the past decades, developments in this field led to its valuation as a premier technique for chemical modification of solid substrates—polymer brushes offer a macromolecular perspective on the modification of interfacial properties of materials.

The creativity of chemists provided a means for developing a wide variety of polymer brushes with unprecedented interfacial properties. Most of this progress stemmed from interdisciplinary work exploiting polymer chemistry as a key enabler to rationally design *polymer interfaces and macromolecular assemblies* entirely from scratch. Properties such as biocompatibility, wettability, corrosion resistance, friction, affinity to a specific target molecule, or even electroactivity can be manipulated by modifying a substrate with polymer brushes. Owing to their flexibility to create macromolecular interfaces in which chemical composition, thickness, and film architecture can be controlled and even addressed with nanoscale precision, polymer brushes have found applications in multiple areas concerning new adhesive materials, protein-resistant or protein adhesive biosurfaces, chemical gates, microfluidic devices, and drug delivery platforms, among other examples.

Polymer brushes constitute indeed a remarkable and growing category within the world of polymer science. A research field where engineering the integration and combination of macromolecular building blocks at the nanometer and molecular level leads to new opportunities for the development of novel and improved interfacial architectures.

For several years now, innovative research in polymer brushes is no longer circumscribed to the realm of polymer science but has begun to enter the domain of physical chemistry, nanoscience materials science, and biotechnology as well. This transformation was catalyzed by the development of new polymerization techniques, which introduced less demanding synthetic strategies facilitating scientific community-wide access to an expertise so far believed to be exclusive domain of polymer chemists.

Nowadays, polymer brushes represent a fertile ground to harness the chemical, physical, or biological activity of a myriad of macromolecular components and put them to work onto a broad variety of surfaces with specific purposes in mind.

This book covers the most relevant topics in basic research and those having potential technological applications. We acknowledge the considerable effort of each of the authors who has made excellent contributions to this book. We believe they have done a splendid job, and that their work will make this book a valuable reference and teaching resource.

Last, but not least, we hope this book will contribute to give the reader a feeling of the enormous potential, the multiple applications, and the many up-and-coming trends behind the development of macromolecular interfaces based on the use of polymer brushes.

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Polymer and Biopolymer Brushes

Polymer and Biopolymer Brushes

for Materials Science and Biotechnology

Volume 2

Edited by

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This book is dedicated to our families.

Igal Szleifer also wants to dedicate this book to his coauthor Omar Azzaroni, who took over the bulk of the work after Prof. Szleifer suffered a stroke in October 2015. If not for Omar's work and dedication, this book would not have materialized. Igal is truly grateful.

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Preface

Polymers at interfaces is a field which has fascinated physicists and chemists now for nearly half a century, with respect to both basic and applied research. Polymer brushes refer to polymeric assemblies tethered at one end to a solid substrate either through covalent attachment or physical adsorption. At sufficiently high grafting density, due to repulsive interactions, the tethered chains stretch away from the surface into the solvent creating polymer brush structure. The conceptual origins of polymer brushes can be traced back to the 1950s, when it was discovered that flocculation could be prevented by grafting polymer chains onto colloidal particles. Over the past decades, developments in this field led to its valuation as a premier technique for chemical modification of solid substrates—polymer brushes offer a macromolecular perspective on the modification of interfacial properties of materials.

The creativity of chemists provided a means for developing a wide variety of polymer brushes with unprecedented interfacial properties. Most of this progress stemmed from interdisciplinary work exploiting polymer chemistry as a key enabler to rationally design *polymer interfaces and macromolecular assemblies* entirely from scratch. Properties such as biocompatibility, wettability, corrosion resistance, friction, affinity to a specific target molecule, or even electroactivity can be manipulated by modifying a substrate with polymer brushes. Owing to their flexibility to create macromolecular interfaces in which chemical composition, thickness, and film architecture can be controlled and even addressed with nanoscale precision, polymer brushes have found applications in multiple areas concerning new adhesive materials, protein-resistant or protein adhesive biosurfaces, chemical gates, microfluidic devices, and drug delivery platforms, among other examples.

Polymer brushes constitute indeed a remarkable and growing category within the world of polymer science. A research field where engineering the integration and combination of macromolecular building blocks at the nanometer and molecular level leads to new opportunities for the development of novel and improved interfacial architectures.

For several years now, innovative research in polymer brushes is no longer circumscribed to the realm of polymer science but has begun to enter the domain of physical chemistry, nanoscience materials science, and biotechnology as well. This transformation was catalyzed by the development of new polymerization techniques, which introduced less demanding synthetic strategies facilitating scientific community-wide access to an expertise so far believed to be exclusive domain of polymer chemists.

Nowadays, polymer brushes represent a fertile ground to harness the chemical, physical, or biological activity of a myriad of macromolecular components and put them to work onto a broad variety of surfaces with specific purposes in mind.

This book covers the most relevant topics in basic research and those having potential technological applications. We acknowledge the considerable effort of each of the authors who has made excellent contributions to this book. We believe they have done a splendid job, and that their work will make this book a valuable reference and teaching resource.

Last, but not least, we hope this book will contribute to give the reader a feeling of the enormous potential, the multiple applications, and the many up-and-coming trends behind the development of macromolecular interfaces based on the use of polymer brushes.

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