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Editors

Thermal Degradation of Polymer Blends, Composites and Nanocomposites

 Springer

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ISSN 1612-1317

Engineering Materials

ISBN 978-3-319-03463-8

DOI 10.1007/978-3-319-03464-5

ISSN 1868-1212 (electronic)

ISBN 978-3-319-03464-5 (eBook)

Library of Congress Control Number: 2015934683

Springer Cham Heidelberg New York Dordrecht London

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Printed on acid-free paper

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(www.springer.com)

Preface

This book on “Thermal Degradation of Polymer Blends, Composites and Nanocomposites” summarizes many of the recent research accomplishments in the area of thermal stability of polymer blends, composites, and nanocomposites such as advances in thermal degradation of blend, composites and nanocomposites, thermal degradation of thermosetting blends, thermal degradation of thermosetting nanocomposites, effect of thermo-oxidation on the mechanical performance of polymer-based composites for high temperature applications, analysis for thermal degradation of a polymer by factor analysis, radiation effects on polymer-based systems, thermal degradation of synthetic rubber nanocomposites, outdoor exposure degradation of ethylene-vinyl-acetate, encapsulant material for photovoltaic application, thermal degradation of bio-nanocomposites, etc.

As the title indicates, the book emphasizes the various aspects of thermal stability of polymer blends, composites, and nanocomposites. This book is intended to serve as a “one stop” reference resource for important research accomplishments in the area of thermal stability-based nanocomposites book. This book will be a valuable reference source for university and college faculties, professionals, post-doctoral research fellows, senior graduate students, researchers from R&D laboratories working in the area of thermal stability-based nanocomposites. The various chapters in this book are contributed by prominent researchers from industry, academia, and government/private research laboratories across the globe. It covers an up-to-date record of the major findings and observations in the field of thermal stability-based nanocomposites. The first chapter on thermal stability-based nanocomposites gives an overview of the area of the state of the art, new challenges, and opportunities of thermal stability-based studies and research, chemistry of thermal degradation of polymers, chemistry of thermal degradation of nanocomposites, and future trends.

The following chapter provides a good structure of thermal degradation of thermosetting blends. In this chapter, the authors explain the literature studies on recent advances concerning the thermal behavior of different thermosetting blends. The introduction debates the general issue concerning polymer blends, that is, the occurrence of phase separation phenomena and lists a series of possibilities to

overcome these undesired aspects. The introduction section also presents the most common polymers used as crosslinked scaffolds either individual or for different multicomponent polymeric materials. The subchapters that follow are focused on recent studies on the thermal stability and degradation of thermosetting blends, effect of reinforcement and nanofillers on the thermal stability of thermosetting blends, and applications and future trends of thermosetting blends, dealing with the latest issues and trying to reveal solutions.

The third chapter on thermal degradation of thermosetting nanocomposites discusses the rapidly-developing nanotechnology and nanoscience in recent years on thermosetting nanocomposites thermal degradation. The authors explain the effect of different nanoparticles, their dispersion, and use of modifiers on the polymer thermal stability. This chapter focuses on the thermal degradation study of thermosetting nanocomposites materials, evaluating their effect in thermal stability and in thermal degradation steps. The thermal applications of these nanocomposites are also evaluated and the challenges to the nanocomposites field in the following years are discussed. The next chapter mainly concentrates on the effect of thermo-oxidation on the mechanical performance of polymer-based composites for high temperature applications. This chapter explains the effect of thermo-oxidation on the mechanical properties of polymer-based composites for high temperature applications. The polymer-based composites with high thermal stability and future trend towards modification of this type of composites have been discussed in this chapter.

The fifth chapter explains the analysis of thermal degradation of a polymer by factor analysis. In this chapter is introduced an application of multivariate curve resolution (MCR) technique based on factor analysis. The authors explain not only series of IR spectra but also two-dimensional data series of nuclear magnetic resonance (NMR), mass spectrometry (MS), and X-ray diffraction (XRD) that can deal in the same manner further two-dimensional data generated by hyphenated techniques such as gas chromatography/mass spectrometry (GC/MS) and liquid chromatography/ultraviolet (LC/UV) analysis, which combine two functions based on different principles, namely chromatography, which has a separating function, and spectrometry, which provides information related to molecular structure. Another chapter on radiation effects on polymer-based systems explains the improvements in thermal properties of polymeric materials/composites with effect of crosslinking and grafting on the thermal properties of polymer materials and composites. The authors also explain with accelerated degradation by radiation exposure.

The seventh chapter explains thermal degradation of synthetic rubber nanocomposites. The authors explain synthetic rubbers nanocomposites that have captured and held the attention of scientists as the materials of the future; these materials improve resistance to thermal degradation and stability of nanocomposites. They explain in this chapter these new materials that exhibit enhanced properties at very low filler level, usually ≤ 5 wt %. The properties of rubber nanocomposites strongly depend on the dispersion state of fillers and method of preparation. The effect of different nanoparticles on rubber properties is studied with thermal stability. This is mainly studied using TGA, TGA-MS TGA-FTIR

and other techniques. Finally, the authors explain that rubber synthetic nanocomposites play an important role in engineering, automotive, aerospace, construction, packaging, and medical device applications due to the possibility to design new materials with unprecedented and improvements in their physical properties, particularly from the perspective of applications.

The eighth chapter discusses the outdoor exposure degradation of Ethylene-Vinyl-Acetate (EVA) encapsulant material for photovoltaic application. The authors explain the outdoor exposure of the materials leading to changes in polymer morphology. The main objective of this experimental investigation was to better understand the changes due to thermal transitions and the molecular organizations of the crosslinked ethylene-vinyl-acetate encapsulant material after aging in outdoor exposure. The authors discuss from the results, the significant decrease in most properties of EVA in natural field exposure due principally to the specificity of the exposure site. For aged EVA samples, the distinctive feature of these results is that there are two different endothermic processes due to the recrystallization phenomenon. Furthermore, the difference in the magnitude of peak current by TSC technique suggests increased crosslinking exposure occurring selectively in the high temperature phase as a result of outdoor exposure. The final chapter on thermal degradation of bio-nanocomposites explains the type of biomaterials and their nanocomposite thermal properties. This chapter reviews the recent developments in bio-nanocomposites where the related biodegradable polymers include Polylactic acid (PLA), polycaprolactone (PCL), polyhydroxyvalerate (PHV), polyhydroxyalkanoates (PHAs), polyhydroxybutyrate (PHB), poly(3-hydroxybutyrate-co-3-hydroxyvalerate) (PHBV), and poly(d,l-lactide) (PDLLA). A concise history outlining the development of bio-nanocomposites materials is explored, while the importance of environmental conditions and in particular the rate of biodegradability is highlighted. Furthermore, the authors discussed in this chapter the steps of thermal degradation and the systematic approaches used to overcome these concerns. It discusses the behavior of various nanoparticles on the thermal stability of biopolymers and other topics related to research challenges, future trends, and applications.

Finally, the editors would like to express their sincere gratitude to all the contributors of this book, who gave excellent support for the successful completion of this venture. We are grateful to them for the commitment and the sincerity they have shown toward their contribution in the book. Without their enthusiasm and support, the compilation of a book would not have not possible. We would like to thank all the reviewers who have taken their valuable time to give critical comments on each chapter. We also thank the publisher Springer for recognizing the demand for such a book, and for realizing the increasing importance of the area of “Thermal Degradation of Polymer Blends, Composites and Nanocomposites” and for starting such a new project, in which not many other publishers put their hands on.

P.M. Visakh

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