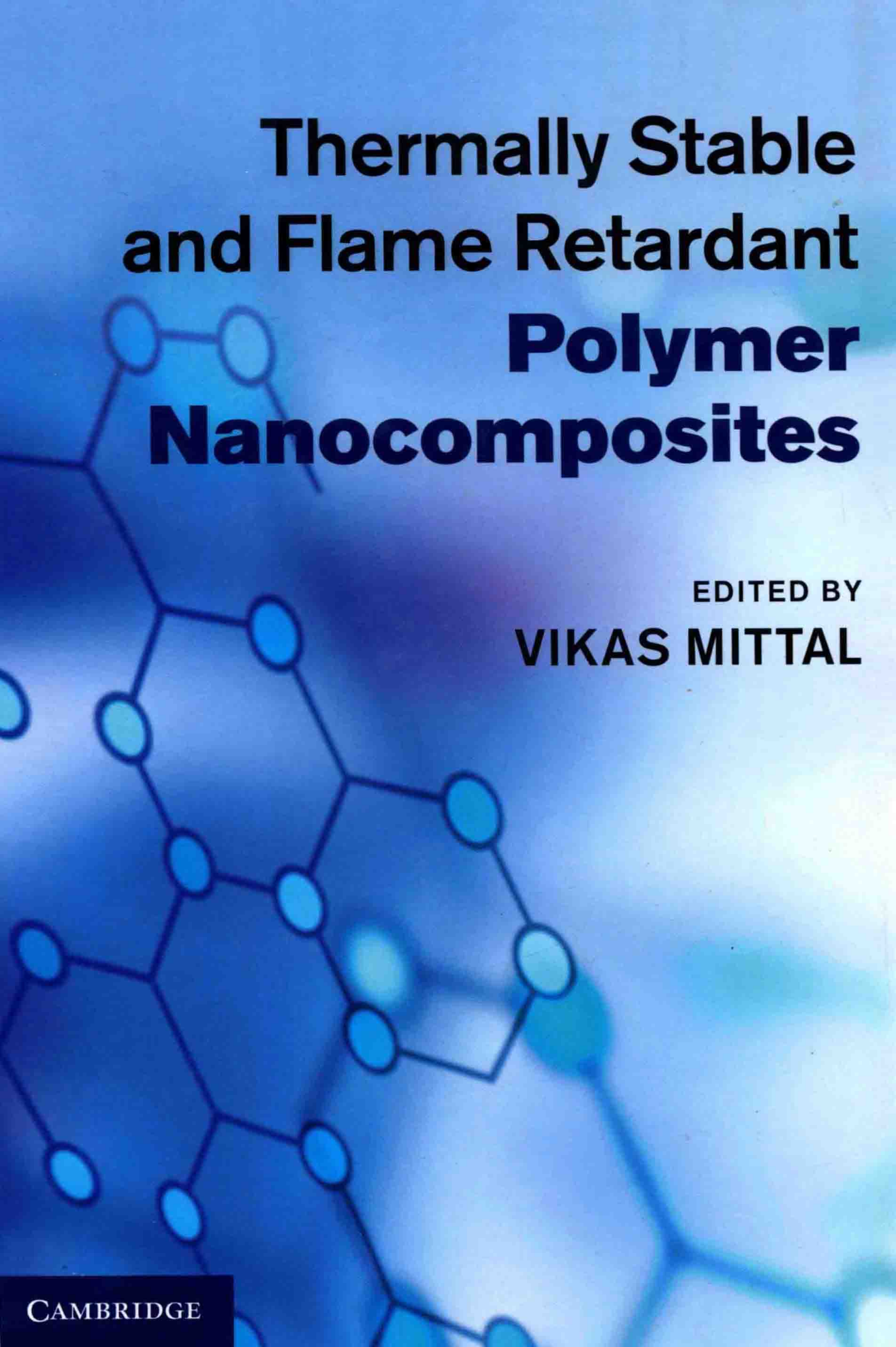

# Thermally Stable and Flame Retardant Polymer Nanocomposites

EDITED BY
VIKAS MITTAL

CAMBRIDGE

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# THERMALLY STABLE AND FLAME RETARDANT POLYMER NANOCOMPOSITES

Polymer nanocomposites have revolutionized material performance, most notably in the plastics, automotive, and aerospace industries. However, to be commercially viable, many of these materials must withstand high temperatures. In this book, leaders in the field outline the mechanisms behind the generation of suitable polymer systems, pulling together recent research to provide a unified and up-to-date assessment of recent technological advances. The text is divided into two clear sections, introducing the reader to the two most important requirements for this type of material: thermal stability and flame retardancy. Special attention is paid to practical examples that walk the reader through the numerous commercial applications of thermally stable and flame retardant nanocomposites. With a strong focus on placing theory within a commercial context, this unique volume will appeal to practitioners as well as researchers.

VIKAS MITTAL is a polymer engineer at The Petroleum Institute in Abu Dhabi, UAE. Dr. Mittal is well known within the academic and industrial sectors for his work on polymer nanocomposites. He has authored several papers and book chapters on the subject, and his research interests also include novel filler surface modifications, thermal stability enhancements, and polymer latexes with functionalized surfaces.

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# Preface

The aim of this book is to provide comprehensive information about the two most important facets of polymer nanocomposites technology, thermal stability and flame retardancy. These two effects ensure a large number of potential applications of polymer nanocomposites. This book provides information regarding their mechanisms of action, as well as practical examples of recent advances in the generation of polymer nanocomposites that are thermally stable and flame retardant.

Polymer nanocomposites revolutionized research in the composites area through the achievement of nanoscale dispersion of the inorganic filler (clay platelets) in the polymer matrices after suitable surface modification of the filler phase. A large number of polymer matrices were tried, and nanocomposites with varying degrees of success were achieved with these polymer systems. In many instances, the generation of nanocomposites requires the use of high compounding temperatures for uniform mixing of the organic and inorganic phases. Conventional filler surface modifications are generally not stable enough for such high compounding temperatures, which initiate degradation reactions in the modification as well as in the polymer matrix. Apart from this, for the successful use of polymer nanocomposites in a number of applications, the materials should withstand high temperatures, making thermal stability a prime requirement for these materials. Similarly, flame retardancy is also of immense importance. A number of advances in thermally stable and flame retardant nanocomposite systems have been achieved in recent years. More thermally stable surface modifications for the fillers have been reported, and corresponding composites with superior thermal resistance have been obtained. Similarly, by incorporation of inorganic clay platelets, nanotubes, oxide nanoparticles, and other materials, the flame retardancy of polymer nanocomposites has been improved.

The first section of the book deals with the thermal stability of layered silicates and polymer nanocomposites. Chapter 1 provides an overview of layered silicates as fillers, organic surface modification of such layered silicates, and thermal stability considerations in relation to the surface modification molecules ionically exchanged on the filler surface. Chapter 2 provides in-depth information on the mechanisms of thermal degradation of layered silicates modified with ammonium and other thermally stable filler surface modifications. Chapter 3 provides the example of generating thermally stable polystyrene nanocomposites using thermally stable layered silicates as fillers. Chapter 4 focuses on the generation of thermally stable PET nanocomposites. Thermally stable polyimide nanocomposites are described in Chapter 5. Use of clays modified with thermally stable ionic liquids for the generation of polyolefin and polylactic acid–based nanocomposites is presented in Chapter 6. In the second section, dealing with flame retardancy considerations, Chapter 7 provides an introduction to the flame retardancy of polymer–clay nanocomposites. Chapter 8 describes flame retardant nanocomposites using polymer blends. Flame retardancy of polyamide–clay nanocomposites is presented in Chapter 9. Chapter 10 reports self-extinguishing polymer–clay nanocomposites. Chapter 11 describes the use of fullerenes as fillers for the generation of flame retardant polymer nanocomposites. Chapter 12 describes flame retardant polymer nanocomposites with alumina as filler. Layered double hydroxides are shown as fillers for the generation of flame retardant polymer nanocomposites in Chapter 13. Flame retardant SBS–clay nanocomposites are described in Chapter 14.

It gives me immense pleasure to thank Cambridge University Press for their kind acceptance of this book. I dedicate this book to my mother for being a constant source of inspiration. I express heartfelt thanks to my wife Preeti for her continuous help in editing the book, as well as for her ideas on how to improve the manuscript.

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