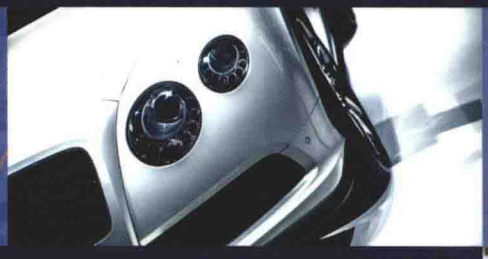
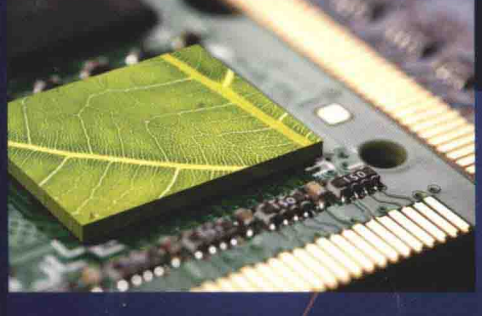
Polymer Science and Plastics Engineering



Nanocellulose Polymer Nanocomposites

Fundamentals and Applications



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To my parents and teachers who helped me become what I am today

Vijay Kumar Thakur

Preface

The increasing environmental awareness has resulted in a renewed interest in polymer nanocomposites that are procured from biorenewable polymers such as nanocellulose. These polymer nanocomposites offer higher thermal and mechanical properties, transport barrier, thermal resistivity and flame retardance in comparison with the conventional biocomposites. Nanocomposite describes a two-phase material where one of the phases has at least one dimension in nanometre range (1–100 nm). They differ from conventional composites by the exceptionally high surface to volume ratio of the reinforcing phase and/or its exceptionally high aspect ratio. The reinforcing material can be made up of particles (e.g. minerals), sheets (e.g. exfoliated clay stacks) or fibers (e.g. carbon nanotubes, electrospun fibers or cellulose nanofibers). Large reinforcement surface area means that a relatively small amount of nanoscale reinforcement can have an observable effect on the macroscale properties of the composites. The ability to control the material features at the nanoscale and evaluation of their influence on the micro and macroscopic properties provides a new aspect to the development of nanocomposite systems. There has been enormous interest in the commercialization of nanocomposites for a variety of applications, and a number of these applications are already found in the market. Nanocomposites are currently used in a number of fields and new applications are continuously sought after.

In line with the development of nanotechnology and recent concern about environmental issues, more attention is being paid to utilizing bio-based nano-materials. In this regard, nanocellulose has gained much more interest because of the promising characteristics such as biodegradable nature, renewability and lower price. Nanocellulose-based materials are showing significant interest as potential nanofillers for nanocomposites due to their nanoscale dimension (very high surface area-to-volume ratio), high aspect ratio and impressive mechanical properties (or nano-strength) imparting to desired nanocomposites. Advantages in the use of nanosize cellulosic materials are related not only to these properties, in fact, its dimensions, in the nanometer scale, open a wide range of possible properties to be discovered. Nanosize cellulosic materials can be isolated from a variety of cellulosic resources, including plants, animals (tunicates), bacteria, algae, and in principle could be extracted from almost any cellulosic material by using different procedures. Remarkable achievements have been witnessed in green technology of cellulose nanomaterials in the field of materials science including the development of bio-nanocomposites. The growing interest in green product and unsurpassed physical and chemical properties of nanocellulose has resulted in increased academic and industrial interests towards development of cellulose nanocomposites. However, there are still some issues to be overcome and main challenges in the field are related to an efficient separation of nanosize cellulosic materials from the natural resources. The non-compatible nature of nanocellulose with most of the polymers is also a crucial issue for its application in nanocomposites. In addition, the

drying process of nanocellulose for application in polymer composite is another challenge. Last but not least is that we need to find a process for obtaining higher yields in nanocellulose isolation. All these challenges and drawbacks have become the strong driving forces for discovering more efficient processes and technologies to produce nanocelluloses for application in nanocomposites, and for inventing new applications as well.

This book is aimed to provide a detailed knowledge on the issues mentioned above. It also provides a comprehensive overview on the synthesis and applications of nanocellulose-based nanocomposites materials. This book discusses extensive developments for the next generation research in the field of nanocellulose-based nanocomposites. The book contains seventeen chapters and each chapter addresses some specific issues related to nanocellulose and also demonstrates the real potentialities of these materials in different domains.

The principal credit of this goes to the authors of the chapters for summarizing the science and technology in the exciting area of nanocellulose. I would also like to thank Martin Scrivener of Scrivener Publishing along with Dr. Srikanth Pilla (Series Editor) for their invaluable help in the organisation of the editing process.

Finally, I would like to thank my parents and wife Manju for their continuous encouragement and support.

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