

# Design, Processing, and Challenges of Multicomponent Polymer Composites for Improved Electromagnetic Interference Shielding Properties: A Review

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The colossal development of modern electronic devices has inevitably led to an increase in electromagnetic interference (EMI), which has gradually become the fourth most prevalent type of pollution in the world. It is therefore necessary to seek more effective EMI-shielding materials to overcome the shortcomings of conventional metal-based materials, which include high density, a lack of mechanical flexibility, low corrosion resistance and costly processing. Conductive polymer composites (CPCs) have attracted more and more attention due to their superiority in many aspects. However, their performances should be further enhanced for future applications. One polymer with only one type of filler often cannot meet this kind of requirement. In this paper, filled polymer materials for EMI shielding are reviewed in terms of their processing, rheological properties, conductivity, and shielding effectiveness. Moreover, the combination of different ingredients and fillers when fabricating multicomponent composites for EMI shielding is also highlighted. The coordination of various components in composites with different structures, including solid, segregated, layered/sandwiched, and foamed/porous structures, is then discussed.

electronic devices. This allows the transport of energy without a physical support,<sup>[1]</sup> and the use and the properties of each type of electromagnetic radiation are determined by the way that it interacts with matter and by its frequency. The following Figure 1 by Marion<sup>[2]</sup> depicts a classification of the different types of EMR or electromagnetic waves based on their frequency and wavelength.

Visible light, radio, TV, and infrared waves, along with X rays, ultraviolet, microwaves, and gamma ( $\gamma$ ) rays are all electromagnetic waves. The electromagnetic waves' spectrum can be divided into categories based on frequency. There are low-frequency waves (< 300 Hz), intermediate-frequency waves (between 300 Hz and 10 MHz) and high-frequency waves (> 10 MHz).<sup>[3]</sup>

## 1.2. Risks Related to EMR

With the coming era of 5G and new telecom services to come, more electromagnetic (EM) waves<sup>[4]</sup> have resulted from the rapid development of electronic communication and electronic devices, which has caused remarkable problems of EM interference (EMI). For example, EM waves deteriorate the performance of electronic devices, and the

## 1. Introduction

### 1.1. Electromagnetic Radiation (EMR)

Electromagnetic radiation (or waves) is a type of radiation used broadly in the telecommunications field and in a large variety of

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## **Processing And Design Of Multicomponent Materials Md:**

**Multicomponent Polymeric Materials** Jin Kuk Kim, Sabu Thomas, Prosenjit Saha, 2016-08-26 The book offers an in depth review of the materials design and manufacturing processes employed in the development of multi component or multiphase polymer material systems This field has seen rapid growth in both academic and industrial research as multiphase materials are increasingly replacing traditional single component materials in commercial applications Many obstacles can be overcome by processing and using multiphase materials in automobile construction aerospace food processing and other chemical industry applications The comprehensive description of the processing characterization and application of multiphase materials presented in this book offers a world of new ideas and potential technological advantages for academics researchers students and industrial manufacturers from diverse fields including rubber engineering polymer chemistry materials processing and chemical science From the commercial point of view it will be of great value to those involved in processing optimizing and manufacturing new materials for novel end use applications The book takes a detailed approach to the description of process parameters process optimization mold design and other core manufacturing information Details of injection extrusion and compression molding processes have been provided based on the most recent advances in the field Over two comprehensive sections the book covers the entire field of multiphase polymer materials from a detailed description of material design and processing to the cutting edge applications of such multiphase materials It provides both precise guidelines and general concepts for the present and future leaders in academic and industrial sectors

*Thermophysical Properties of Multicomponent Liquid Alloys* Jürgen Brillo, 2016-03-21 The book gives an understanding on how thermophysical properties change as function of alloy composition and complexity In order to reach this goal data on density surface tension and viscosity as functions of alloy composition and temperature are measured and discussed for pure liquid elements liquid binary and ternary alloys

*Multicomponent Hydrogels* Jagan Mohan Dodda, Kalim Deshmukh, Deon Bezuidenhout, 2023-05-22 Hydrogels are highly hydrated three dimensional networks with the ability to mimic the extracellular matrix of bodily tissues and have thus found application in a wide range of biomedical applications Unique physiochemical properties such as biocompatibility water permeability stimuli responsiveness and self healing characteristics make them especially useful for use as scaffolds and matrices drug delivery tissue engineering regeneration and sensing Their weak and brittle nature however often limits their widespread application where improved mechanical strength is required To resolve this problem there has been a significant amount of research into the improvement of their mechanical properties Among these efforts versatile multicomponent hydrogels have received much attention as their physiochemical properties can be structurally engineered to provide a wide range of desired properties These multicomponent formulations also allow for the combination of natural and synthetic polymers which offers the scope to exploit the advantages of each component with the synergistic effects resulting from mutual interactions This book critically discusses the fundamental

chemistry synthesis characterisation physiochemical and biological properties of various types of multicomponent hydrogels It reviews the different strategies employed in designing and synthesizing cutting edge multicomponent hydrogels and their key applications in biomedical fields The work is suitable for researchers working in the specific area of multicomponent hydrogels and also more generally for those working in materials science biomedical engineering biomaterials science and tissue engineering

**Processing and Design of Multicomponent Materials** M. Cengiz Altan, Merve Erdal, André Bénard, 2000

**Thermal Process Modeling 2014:** B. Lynn Ferguson, Robert Goldstein, Scott MacKenzie, and Rozalia Papp, 2014-06-01 Thermal processes are key manufacturing steps in producing durable and useful products with solidification welding heat treating and surface engineering being primary steps These papers represent the latest state of the art in thermal process modeling The breadth of topics covers the depth of the industry

Multi-material Injection Moulding V. Goodship, J. C. Love, 2002 Many variations of injection moulding have been developed and one of the rapidly expanding fields is multi material injection moulding This review looks at the many techniques being used from the terminology to case studies The three primary types of multi material injection moulding examined are multi component multi shot and over moulding The basic types of multi material injection moulding the issues surrounding combining different types of polymers and examples of practical uses of this technology are described

**ISMANAM-2004** Akihisa Inoue, 2005-09-01 ISMANAM 2004 Proceedings of the 11th International Symposium on Metastable Mechanically Alloyed and Nanocrystalline Materials held in Sendai Japan 22nd to 26th 2004

Combinatorial Materials Synthesis Xiao-Dong Xiang, Ichiro Takeuchi, 2003-08-19 Pioneered by the pharmaceutical industry and adapted for the purposes of materials science and engineering the combinatorial method is now widely considered a watershed in the accelerated discovery development and optimization of new materials Combinatorial Materials Synthesis reveals the gears behind combinatorial materials chemistry and thin film technology and discusses the prime techniques involved in synthesis and property determination for experimentation with a variety of materials Funneling historic innovations into one source the book explores core approaches to synthesis and rapid characterization techniques for work with combinatorial materials libraries

**NBS Special Publication**, 1968

*Fuzzy Logic-based Material Selection And Synthesis* Mustafa B Babanli, 2019-03-04 This unique compendium presents a comprehensive and self contained theory of material development under imperfect information and its applications The book describes new approaches to synthesis and selection of materials with desirable characteristics Such approaches provide the ability of systematic and computationally effective analysis in order to predict composition structure and related properties of new materials The volume will be a useful advanced textbook for graduate students It is also suitable for academicians and practitioners who wish to have fundamental models in new material synthesis and selection

*Fluid Transport in Nanoporous Materials* Wm. Curtis Conner, Jacques Fraissard, 2006-05-06 The last several years have seen a dramatic increase in the synthesis of new nanoporous materials The most promising include molecular sieves which are being developed as

inorganic or polymeric systems with 0.3–30 nm in pore dimensions. These nanoporous solids have a broad spectrum of applications in chemical and biochemical processes. The unique applications of molecular sieves are based on their sorption and transport selectivity. Yet the transport processes in nanoporous systems are not understood well. At the same time the theoretical capabilities have increased exponentially catalyzed by increases in computational capabilities. The interactions between a diffusing species and the host solid are being studied with increasing details and realism. Further in situ experimental techniques have been developed which give an understanding of the interactions between diffusing species and nanoporous solids that was not available even a few years ago. The time was ripe to bring together these areas of common interest and study to understand what is known and what has yet to be determined concerning transport in nanoporous solids. Molecular sieves are playing an increasing role in a broad range of industrial, petrochemical and biological processes. These include shape selective separations and catalysis as well as sensors and drug delivery. Molecular sieves are made from inorganic as well as organic solids e.g. polymers. They can be employed in packed beds as membranes and as barrier materials. Initially the applications of molecular sieves were dominated by the use of zeolites.

**Polymer Science and Engineering** National Research Council, Division on Engineering and Physical Sciences, Commission on Physical Sciences, Mathematics, and Applications, Committee on Polymer Science and Engineering, 1994-01-01. Polymers are used in everything from nylon stockings to commercial aircraft to artificial heart valves and they have a key role in addressing international competitiveness and other national issues. Polymer Science and Engineering explores the universe of polymers describing their properties and wide ranging potential and presents the state of the science with a hard look at downward trends in research support. Leading experts offer findings, recommendations and research directions. Lively vignettes provide snapshots of polymers in everyday applications. The volume includes an overview of the use of polymers in such fields as medicine and biotechnology, information and communication, housing and construction, energy and transportation, national defense and environmental protection. The committee looks at the various classes of polymers: plastics, fibers, composites and other materials as well as polymers used as membranes and coatings and how their composition and specific methods of processing result in unparalleled usefulness. The reader can also learn the science behind the technology including efforts to model polymer synthesis after nature's methods and breakthroughs in characterizing polymer properties needed for twenty first century applications. This informative volume will be important to chemists, engineers, materials scientists, researchers, industrialists and policymakers interested in the role of polymers as well as to science and engineering educators and students.

**Publications of the National Bureau of Standards 1977 Catalog** United States. National Bureau of Standards, 1978. *Publications* United States. National Bureau of Standards, 1978. [Sustainable Design Through Process Integration](#) Mahmoud M. El-Halwagi, 2025-03-26. Sustainable Design through Process Integration: Fundamentals and Applications to Industrial Pollution Prevention, Resource Conservation and Profitability Enhancement. Third Edition provides

authoritative comprehensive and easy to follow coverage of the fundamental concepts and practical techniques on the use of process integration to maximize the efficiency and sustainability in industrial processes Sections cover new information on the inclusion of sustainability objectives within different front end loading stages of design carbon management and monetization design of renewable energy systems and integration with existing infrastructure incorporation of process safety in design resilience principles and design approaches modular design industrial symbiosis and open ended mini projects on sustainable design Provides authoritative comprehensive and easy to follow coverage of the fundamental concepts and practical techniques in the use of process integration to maximize the efficiency and sustainability of industrial processes Helps readers systematically develop rigorous targets that benchmark the performance of industrial processes and develop cost effective implementations Contains state of the art process integration approaches and applications including graphical algebraic and mathematical techniques Covers applications including process economics targeting for conservation of mass and energy synthesis of innovative processes retrofitting of existing systems integration of process components and in process pollution prevention Includes numerous examples and case studies for a broad array of industrial systems and processes *Energy Research Abstracts* ,1979-05 Publications of the National Bureau of Standards United States.

National Bureau of Standards,1984 **Index of Conference Proceedings** British Library. Document Supply Centre,2001

High Entropy Materials Krishanu Biswas,Nilesh Prakash Gurao,Tanmoy Maiti,Rajiv S. Mishra,2022-11-22 This book provides a detailed overview of high entropy materials and alloys discussing their structure the processing of bulk and nanostructured alloys as well as their mechanical and functional properties and applications It covers the exponential growth in research which has occurred over the last decade discussing novel processing techniques estimation of mechanical functional and physical properties and utility of these novel materials for various applications Given the expanding scope of HEAs in ceramics polymers thin films and coating this book will be of interest to material scientists and engineers alike

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