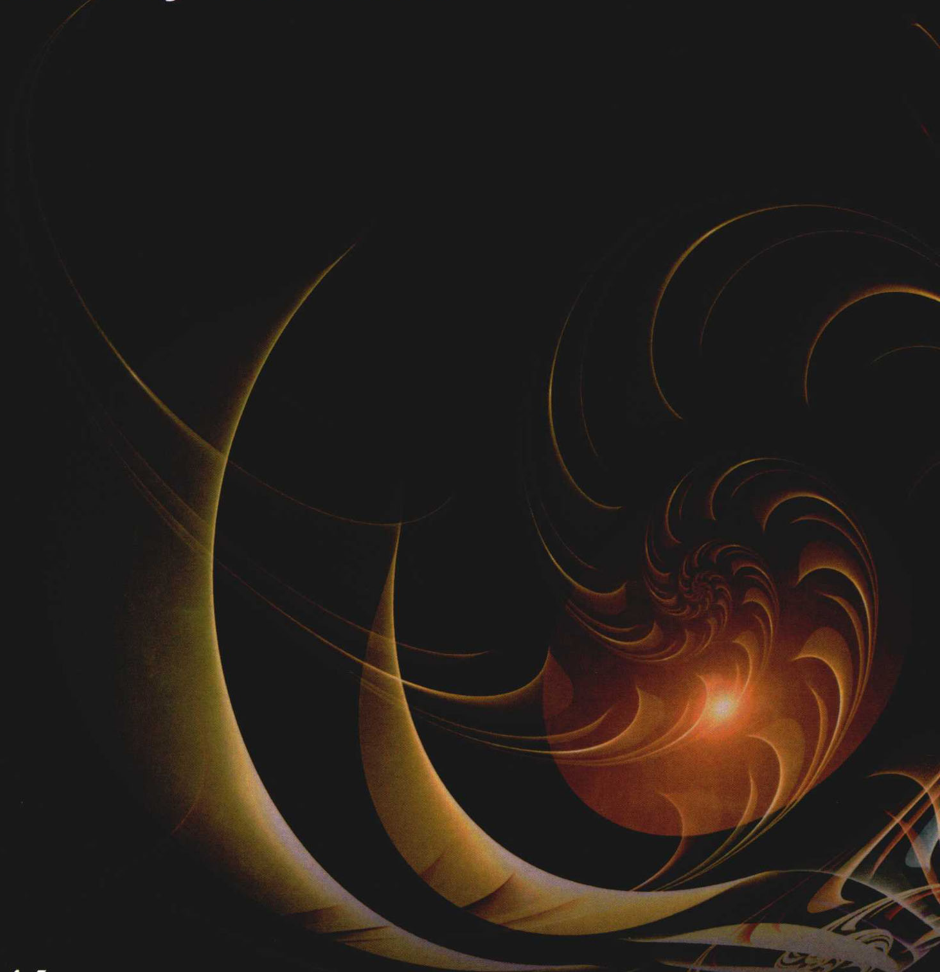
# Encapsulation Nanotechnologies

Edited by Vikas Mittal



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# Encapsulation Nanotechnologies

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# Preface

The encapsulation process is prevalent in the evolutionary processes of nature, where nature protects the materials from the environment by engulfing them in a suitable shell. These natural processes are well known and have been applied to numerous processes in the pharmaceutical, food, agricultural, and cosmetics industries. Thus, this allows one to combine the properties of the various components along with the time point of combination, if the release from such capsules can be controlled.

In recent years, owing to the increased understanding of the material properties and behaviors at nanoscale, research in the encapsulation field has also moved to the generation of nanocapsules, nanocontainers, etc. One such example is the generation of self-healing nanocontainers containing corrosion inhibitors which can be used in anti-corrosion coatings. The processes used to generate such capsules have also undergone significant developments. Various technologies based on chemical, physical and physic-chemical synthesis methods have been developed and applied successfully to generate encapsulated materials.

Owing to the high potential of the developed technologies and products in a large number of commercial processes, it is of significance to compile the recent technological advancements in a comprehensive volume. This volume not only introduces the subject of encapsulation to readers new to the field, but also serves as a reference for experts working in this area.

Chapter 1 details the copper encapsulation of carbon nanotubes. Since copper is a good electrical and thermal conductor and has a low binding energy to carbon, its encapsulation into CNTs would lead to many interesting practical applications. Chapter 2 describes the intercalation of ionically conductive polymers into the layers of molybdic acid. The resulting intercalation compounds were characterized by powder X-ray diffraction (XRD), thermogravimetric analysis (TGA), Fourier-transform infrared spectroscopy (FTIR), and ac impedance spectroscopy. Chapter 3 discusses various aspects of the application of fluid-bed technology for the coating and encapsulation processes. Particular attention has been paid to the principles of the fluidization technique, the miscellaneous fluid-bed coating processes and various coaters configurations with special emphasis on fine powder coating, dry coating and encapsulation. Chapter 4 demonstrates the use of the electrospinning technique for encapsulation. The electrospinning technique, consisting of the application of an electrical voltage to a polymeric solution to generate fiber or capsule-like morphologies, has tremendous potential for the development of encapsulation structures of interest in a number of areas such as biomedicine, food technology, bioremediation, energy storage, etc. Chapter 5 details the concept of microencapsulation by interfacial polymerization. Interfacial polymerization, including polycondensation, polyaddition, *in situ* polymerization as well as other heterophase polymerization processes, is defined by the formation of the capsules shell at or on a droplet or particles by polymerization of reactive monomers. Chapter 6 summarizes the main contributions from the literature for the preparation of a specific example of such hybrid materials, core-shell particles composed of an inner silica core and a poly(methyl methacrylate) outer shell. Chapter 7 provides an overview of recent progress in encapsulation technologies for organic thin-film transistors (OTFTs). General mechanisms of environment-induced degradation to OTFTs is reviewed, along with a discussion on the general requirements of encapsulation. Chapter 8 demonstrates that the derivatives of a hyperbranched polymer (mainly hyperbranched polyethylenimine (PEI)) can encapsulate a variety of guest species, and the encapsulating system shows a rather high guest selectivity, in which a specific interaction is absent or very weak. Chapter 9 presents a description of the initiated chemical vapor deposition (iCVD) process, concentrating on aspects like molecular weight of the deposited polymer, which is important for stability, and deposition rate. Both aspects, molecular weight and deposition rate, are essential for large-scale application in hybrid gas barriers. Chapter 10 provides an overview of the current status of polymer capsule technology, with a specific focus on preparation methods and their areas of application. The preparation of polymer capsules and their general features for applications are addressed. Chapter 11 demonstrates the potentialities of encapsulated ionic liquids (IL) within porous moieties in the proton exchange membranes field.

One approach relies on the IL immobilization in large pore zeolites, which are further deployed as inorganic fillers to the polymer casting solution. Chapter 12 reviews the encapsulation and co-precipitation processes based on the use of supercritical fluids, i.e., carbon dioxide. These processes are classified according to the role of the carbon dioxide (solvent, antisolvent, solute or reaction medium). The focus is set on the process mechanisms description, as well as the evolution of different techniques for overcoming the challenges set according to the physical properties of the different processed materials.

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