MESOPOROUS MATERIALS

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INTRODUCTION

A mesoporous material is a nanoporous material containing pores with diameters between 2 and 50 nm. The development of mesoporous materials has offered great opportunities for new applications in a variety of fields, including heterogeneous catalysis, thanks to their special intrinsic structural features. In this article, we focus on the main achievements of mesoporous materials in both synthesis and catalysis fields. The development of synthesis strategies, especially designed for generating improved physicochemical and textural properties of mesoporous materials, which include silicas, metals, metal oxides, organosilicas, metal-organic frameworks, carbons and zeolites, is briefly summarized with special emphasis on mesoporous zeolites. Adsorbent mesoporous materials are highly efficient for the remediation of different compounds in environmental applications such as organic, inorganic, and gas molecules.

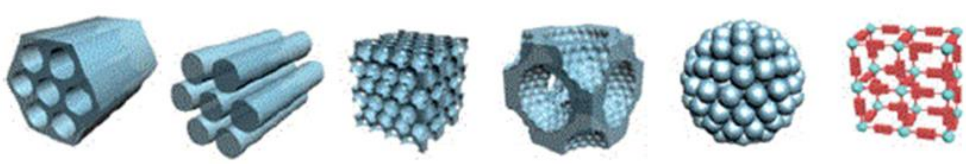

Figure 2: Various type of mesoporous materials.

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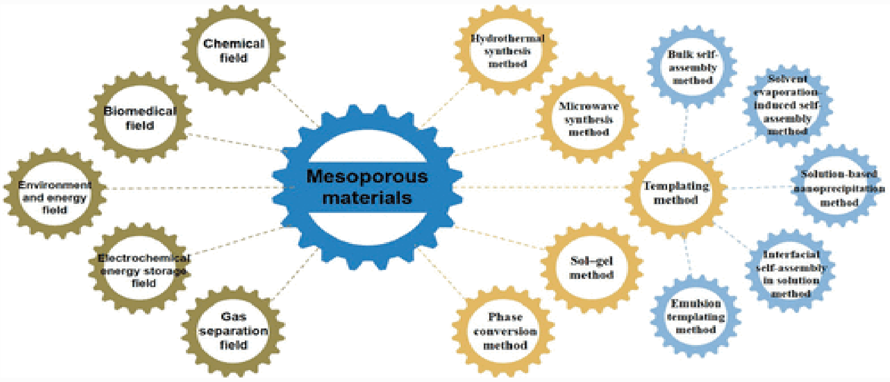
SYNTHESIS AND APPLICATION OF MESOPOROUS MATERIALS

There are many synthetic methods for mesoporous materials. They are hydrothermal synthesis, microwave synthesis, the sol–gel method, the phase conversion method, and the templating method.



CHARACTERIZATION OF MESOPOROUS MATERIALS

The arevarious instrumentation techniques that are used to investigate and characterize mesoporous materials in order to determine particle size, pore morphology, structure and surface information. The key biophysical techniques used to classify the most mesoporous materials are powder X-ray diffraction (XRD), transmission electron microscopy (TEM), scanning electron microscopy (SEM), energy dispersive X-rays are used to characterization techniques for mesoporous materials. Electron crystallography used for characterization.

APPLICATION OF MESOPOROUS MATERIALS

Mesoporous materials are perfect in diagnostics applications because of their enhanced image contrast and chemical stability. Currently the mesoporous materials have been envisaged for a variety of applications such as in energy conversion and storage, filtration, catalysis, optics, drug delivery and so on.

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DRUG DELIVERY SYSTEM

The main challenge in the development of drug delivery systems (DDS) is that drug efficacy diminishes before reaching the target, primarily due to the excretion of the drug from the body. In addition, the drug carrier must be non-toxic and inert during the treatment period. Because most biological molecules and pharmaceuticals are on the order of a few nanometers, nanoporous silica with a pore size of 2 – 30 nm is of great relevance for such life science applications.

CATALYSIS

In catalysis, high surface area materials with nanoscale features are used to develop highly selective catalysts that reduce energy use and waste/pollutant generation in industrial applications. Porous materials, such as zeolites (microporous solids), are widely used in industry as catalysts and catalyst supports.

DIAGONESTICS

Mesoporous materials are ideal in diagnostics applications due to their increased image contrast and chemical stability. Due to the low toxicity of silica based porous materials and their ability to host a variety of fluorescent markers, dyes and drugs can be used to track the location of therapeutic agents and their activity.

ADSORBENTS

Due to the high surface area of nanoporous materials allows their use as adsorbents for various gases, liquids, and toxic heavy metals. The uptake of these substances can be increased significantly based on the surface properties (hydrophobicity, hydrophilicity, or functionality), of the mesoporous silica materials. Several applications, such as removal of pollutants from water, storage, of gases (e.g., CO_2, H_2, O_2, CH_4, H_2S), adsorptive xylene separation, and separation of biological and pharmaceutical compounds, have been addressed through the use of mesoporous materials as adsorbents.

CHROMATOGRAPHY

The large pore volume, surface area, and narrow pore-size distribution of mesoporous silica, makes it a good candidate for size exclusion chromatography. These materials have been proposed as supports or stationary phases for size exclusion chromatography,

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capillary gas chromatography, proteomics separations, normal phase High Pressure Liquid Chromatography (HPLC), as well as enantioselective HPLC.

Mesoporous materials have witnessed a great progress over the past decade. the potential applications of functional mesoporous materials in adsorption, diagnostic, catalysis, and biomedicine have also been discussed. That is very important to advance the chemistry, material science, biology, nanoscience and cross-over fields.

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NOVEL AREAS OF POLYMER RESEARCH

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The recent innovation in polymeric materials has driven social and physical development, polymers and their composites are the material's nerve centre for many practical applications. Some common applications of this new material are in the following fields automotive, sports, gadgets, aircraft, aviation, biomedical, nanotechnology, etc. Investigation of the surface properties of polymeric materials has become of great importance mainly because their interfacial interaction plays a very important role in the reliability of the underlying components. This unique problem requires a thorough investigation of all polymer-containing materials (whether natural or artificial) as one of their constituents. Examples include polymer composites, polymer biomaterials, multifunctional polymers, characteristic polymer materials, etc. Detailed investigation of these polymer materials with improved surface properties by improving physical properties or mechanical properties is rapidly increasing among researchers all over the world.

Polymers are used in a variety of technologies, from avionics to medical applications to pharmaceutical drug-delivery systems, biosensing devices, tissue engineering, cosmetics, etc. Because of their ease of manufacture, the use of polymers and their composites is increasing. When considering a polymer application, understanding its true value requires understanding how the material will perform over a long period of time. These materials can include natural fillers, polymers matrixes, foams, cement and composites, fillers, strands, films, layers, emulsions, coatings, Rubber, fasteners, glue resins, solvents, inks and paints, clothing, flooring, waste disposal Sacks and bundles of polymers. Automobile parts, windshields of military aircraft, pipes, tanks, pressing

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materials, protection, wood substitutes, cement, composite frames, and elastomers are some modern applications of today's polymers.

The use of natural fibers as reinforcing materials has been reported although it is possible to rediscover them on the technological track only recently dated back to the early 20th century. Currently seeks great importance to the task of enriching natural fibers in various biodegradable and non-biodegradable polymer matrices. Using natural fibers and fillers can be seen as a way of dealing with manufacturing issues and sustainable material systems for polymer composites. Using fibers from natural plant systems is a sustainable and economical option to enter the field of composite materials that are environmentally friendly, rich, and sustainable with a short throughput time and development cycle. With the continuous aggravation of environmental pollution and the continuous increase of garbage generation, there has been an increasing emphasis on developing new technologies using biodegradable reinforcement materials for the continuing needs of society. Among other natural fibers, naturally occurring cheap basalt fibers are made from crushed basalt and have the following unique properties: biodegradability, excellent key properties such as increased thermal stability, mechanical properties, etc. Basalt fiber-reinforced polymer composites have a wide range of applications in civil construction, automobile, aerospace, anti-radiation shielding, and other applications. Radioactivity through hazardous nuclear waste, insulation materials, etc. Basalt fibers also have sufficient capabilities to be recognized as a next-generation reinforcing material for structural applications, consumer applications, and mobility applications. Nanomaterial-reinforced polymer composites also play an important role in high-strength applications.

With the development of polymer technology, a new type of conductive polymers has emerged as potential materials for various charge transfer applications. The electronic conductivity of such polymers is tuned by doping and de-doping the materials. Recently, various conductive polymer composites have been successfully used as gas-sensing materials due to their unique electron-conducting properties and effective redox chemistry. The fabrication of composites of functional materials with conductive polymers improves the structural and physiochemical properties that always lead to high-performance gas sensors. They provide large surface areas for molecular interaction between the target gas and the sensing elements. They exploit the synergistic effect of the high affinity of polymers for redox reactions and the unique gas sensor properties of

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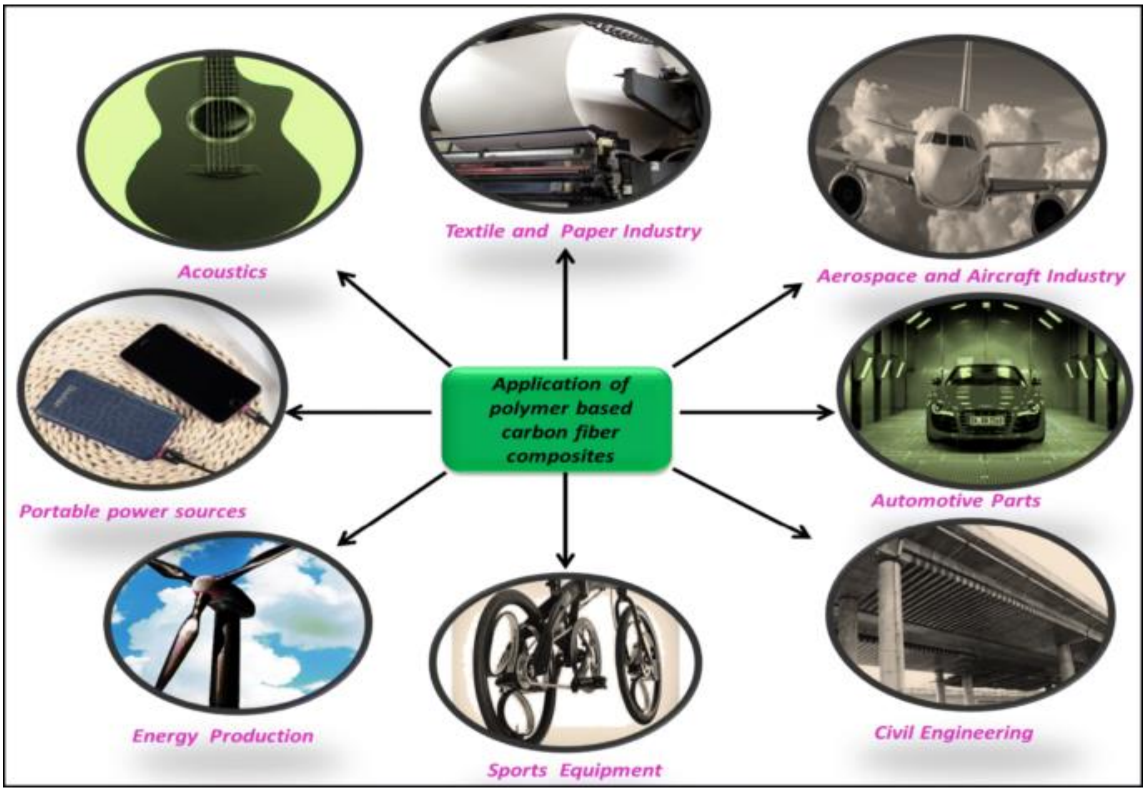
inorganic functional materials. In general, semiconducting metal oxide materials are suitable fillers for the preparation of composites with conducting polymers. Commonly used conducting polymers are derivatives of polyaniline (PANI), polypyrrole, polythiophene, etc. The sensitivity and response time of these materials are important parameters for realizing a high-performance gas sensor. They are promising materials for improving the sensitivity, safety, and selectivity of sensors.

The development of comparatively stronger polymer composites, such as carbon fiber-reinforced polymers, has significantly improved material strength, chemical, and moisture resistance, durability, and interlaminar shear strength. Such reinforced material is widely used in the manufacture and development of multifunctional devices for aircraft, automobiles, biomedical, sensors, and other electronic applications. Machining of carbon filler reinforced polymer composites is significantly different from machining of metals due to plastic deformation, abrasive nature of reinforcement, and inhomogeneous structure. Generally, polymer composites are manufactured with a net shape, but custom machining processes are required for fitting and joining and final assembly.



The type, amount, and mixing technique of the filler contribute significantly to the performance of polymer composites in tribological systems. Due to their lighter weight and lower frictional properties, polymer composites are an important replacement for

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metallic components used in bearings, housings, joints, etc. Polymer composites have very different friction and wear mechanisms compared to metals, mainly due to their softness, lower melting temperature, and lower overall thermal conductivity. The performance of tribological polymer composites also depends largely on the reinforcing materials, the type of fillers used, and the polymer matrices used in the composites. Various polymer composites made from polytetrafluoroethylene, high-density polyethylene, and polyethylene terephthalate have also been explored by various researchers for tribological applications.

Another major area of work is solid-state batteries, which are replacing liquid batteries due to safety considerations related to liquid electrolytes. The increasing demand for electric vehicles over the last decade has forced our society to respond by developing energy storage devices with high energy and power density and with high safety. Solid-state batteries use solid electrolytes, such as metal oxides, solid polymers, and so on. Polymer-based electrolytes have certain advantages over others, such as good flexibility, thermal stability, low flammability, high safety, and so on. However, their low mechanical strength, ion diffusion problems, and rapid decomposition are some of the major challenges. These challenges can be overcome by appropriate manufacturing processes, proper device design, and the use of hybrid materials. The emerging field of flexible electronics supports the use of polymer electrolytes in portable and flexible devices. The commonly used polymer electrolytes are based on poly(acrylonitrile), poly(acrylonitrile-co-butadiene), poly(ethylene oxide), polyvinyl alcohol (PVA), poly(ether acrylate), etc. This monograph contains a collection of application aspects of natural and synthetic polymers.
It is expected that this monograph can provide a consolidated overview of the current state of the art in polymer applications.

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