Chapter

Introductory Chapter: Crystalline Materials and Applications

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1. Introduction

The scientific research and development in crystalline materials science covers the synthesis, crystal structure study, physicochemical properties, and applications of solid crystals (inorganic, organic, hybrid, and organometallic). Indeed, the synthesis and the physicochemical characterization of solid materials with interesting physical properties can bring us back to the specific applications related to their crystalline structures. Accordingly, technological development necessitates the exploration of new crystalline materials.

Currently, energy storage, water treatment, and the synthesis of pharmaceutical products are among the areas of intense research activity in materials chemistry.

Given the high energy demand which continues to increase, with a progressive depletion of fossil fuels, which lead to the emission of greenhouse gases and their environmental impact (greenhouse effect), current scientific research is focused on renewable energy research areas and also energy storage. In this context, the investigation of rechargeable batteries constitutes a system of storage of electrical energy in chemical energy. In fact, the research of new crystalline materials with open frameworks formed by diverse polyhedra (tetrahedra, pentahedra, and octahedra) bounding interlayer spaces and/or tunnels communicating through the intermediary of windows where cations are located is currently a field of intense activity in energy storage, especially Li-ion batteries and Na-ion batteries, etc. [1–9]. The preparation and characterization of new compounds are the driving forces of recent technological development, and studies are progressing through the exchange of views between relevant specialists. On the other hand, new research works on the treatment of batteries are based on degradable polymers such as alkali-cellulose in order to avoid materials based on expensive and less exploited metals (Li) [10].

2. Crystalline materials and applications

As part of the crystalline materials research for biologically active molecules, groups of organic heterocycles appear, such as coumarin derivatives [11, 12], which can be found in the plant kingdom. The synthesis and structural characterization work carried out on these materials constitutes a vast field of research, in which a large number of laboratories are involved in the world. Natural or synthetic compounds are particularly sought after for their biological and pharmaceutical activities. These compounds have been used in different fields of application such as food additives and dyes, as well as in the cosmetics field. In fact, these phases are powerful antioxidants and have antibacterial, hypolipidemic, cholesterol-lowering, and anticarcinogenic properties, which give them a great importance in the pharmaceutical field. Charge transfer agents, solar energy collectors and non-linear optical

materials require materials with inherent photochemical characteristics, reasonable stability and good solubility in some.

Given the enormous increase in industrial activity, enormous quantities of polluting chemical wastes are spreading in the air, soil, and air [13]. In fact, every year more than 2 million gallons of synthetic dyes of which more than 10% are lost in waterways during their use [14]. However, the presence of organic compounds, unwanted metals, and dye waste requires treatments before use. In this context, the photocatalytic treatment of water is one of the treatments used due to the great precision of mineralization of organic compounds, and the ease of the process, in addition to the advantages of replacing filters with all the problems. Regeneration and fouling are associated with their use. Several crystalline materials have been introduced into the filters of the catalytic treatments [15, 16]. These materials have been used to eliminate various types of pollutants such as organic compounds, heavy metals, and others.

This book is dedicated to the investigation of various types of crystalline materials that can be used in several fields nowadays, such as energy storage (rechargeable batteries). Other crystalline compounds can be used in photocatalytic treatments. Other pharmaceutical compounds are also processed due to their interesting biological activities. The synthesis method of each compound is detailed to facilitate those interested in its preparation. As the physical and biological properties of the compound are related to the crystal structure, a description of the structure of each compound has been discussed.

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