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Review

Aluminosilicate and aluminosilicate based polymer composites: Present status, applications and future trends

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ABSTRACT

Aluminosilicates have traditionally been important materials for applications related to adsorbents, water softeners, catalysis and mechanical and thermal reinforcement due to their high surface area, excellent thermal/hydrothermal stability, high shape-selectivity and superior ion-exchange ability. Recently, their use as polymer fillers has allowed to increasingly extending their application range to innovative areas such as medical and biological fields as well as in sensors, filtration membranes, energy storage and novel catalysis routes. Further, the large versatility and tailoring possibilities of both filler and matrix indicates this area as one of the enabling key technologies of the near future.

This work summarizes the main developments up to date in this increasingly interesting field, focuses on the main applications already developed as well as on the key challenges for the near future.

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Contents

1. Introduction

Despite belonging to the group of the more abundant elements on the Earth crust, silicon and aluminum are not found in nature in their elemental form [1]. They combine with oxygen and originate a wide range of chains, rings, layers and three-dimensional arrays. Thus, despite all aluminosilicates share the same basic chemical composition, the different arrangements of atoms and molecules lead to structures with different physico-chemical properties. Natural or synthetic, there exist a large number of different aluminosilicates among which stand out clays, zeolites and mesoporous aluminosilicates. These materials have found a wide range of applications, ranging from catalysis to and mechanical and thermal reinforcement. The many applications are mainly related to their high surface area, excellent thermal/hydrothermal stability, high shape-selectivity and superior ion-exchange ability. Their use as polymer fillers has allowed to steadily increase their application range to new areas, including medical and biological applications, sensors, filtration membranes and energy storage, among others. They have been used both to tailor specific characteristics of the polymers, such as thermal or mechanical properties, and to provide specific functionality no previously existing in the polymer matrix.

This work summarizes some of the main properties of aluminosilicates, that are relevant for the development of novel applications based on polymer composites. The main characteristics of aluminosilicate/polymer composites have been then reviewed, as well as the recent advances related to the development of the composites and the latest application possibilities in areas such as sensors and actuators, filtration membranes, battery separation membranes and biomedical applications, among others. Finally, the key challenges and future trends are outlined.

2. Aluminosilicates

Aluminosilicates share the same basic chemical composition, the different atom and molecular arrangements leading to structures with different properties. The most investigated and applied aluminosilicates include clays, zeolites and mesoporous aluminosilicates. From the point of view of the microstructure, aluminosilicates can be classified in layered and three dimensional.