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Part 1: Specification of characteristics and measurement methods for layered clay nanomaterials

Nanotechnologies — Nano argiles —

Partie 1: Spécification des caractéristiques et des méthodes de mesure des nano argiles en couches

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Foreword

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Introduction

Layered clay nanomaterials are a subgroup of clay materials with the external dimension (thickness) or the internal structural dimension (interlayer distance) in the nanoscale. Clay itself, as most important group of layered nanostructured silicates, refers to naturally occurring or synthetic material composed primarily of fine-grained minerals, which show plasticity through a variable range of water content and will harden when fired or dried. The minerals found in clay are generally silicates of less than 2 micrometres in lateral size. Clays are very abundant at the earth's surface; they form rocks known as shales and are a major component in nearly all sedimentary rocks. The small size of the particles and their unique crystal structures give clay materials special properties, including cation exchange capabilities, plastic behaviour when wet, catalytic abilities, swelling behaviour, and low permeability[1].

Other than the structure and composition, there are several additional factors which are important in determining the properties and applications of clays and clay nanomaterials (see Annex A). These are the mineral impurities, the presence of organic materials, the type and amount of exchangeable ions and soluble salts, and the morphological aspects[2].

Natural and modified clays as layered structured minerals are very important industrial materials. In pristine form, clay materials are normally subnano spaced layers, structured in bundles and in exfoliated state; they are nano-objects with thickness in the nanoscale while in intercalated form they are structured nanomaterials with interlayer space in nanoscale.

Modification of clay with change in its characteristic such as its hydrophobicity, interlayer distance, exchangeable ion, and surface connected groups leads to the extension of its applications e.g. for high performance nanocomposites, effective rheological modifier, or biomedical applications. A small quantity of well dispersed intercalated or exfoliated organo-modified layered clay nanomaterials in polymeric composites (see Annex B) is proved to show superior impacts on properties such as barrier, tensile modulus, mechanical strength, and flame retardancy.

There are numerous industrial applications for layered clay nanomaterials. Purified and modified clays are used as; coatings on paper to enhance whiteness and to allow the proper absorption of ink, the life time extender of rubber in tires, in concrete, as catalysts in many industries. Moreover, they can also be used in oil purification, pharmaceuticals, ceramic industry, soil stabilization, porcelains and barriers for nuclear and chemical wastes because of their cation-exchange capabilities, low permeability, and long-term structural stability. In addition, layered clay nanomaterials are utilized in purification industries, in agricultural and food engineering applications, polymeric nanocomposites, deodorizer, insecticide carrier, pesticides carrier, drilling fluids, desiccant, detergents, plasticizer, emulsion stabilizer, food additives, cosmetic applications, environmental remediation and many other miscellaneous applications[1][2].

For such a wide range of clay nanomaterial applications, various fundamental characteristics (as shown in Table 1) play undeniable roles. These characteristics are measured and reported by the provider of the layered clay nanomaterials. In fact, the determinations of these fundamental and basic characteristics will facilitate the communication between sellers and buyers of these nanomaterials for different applications. These characteristics are considered for all industrial layered clay nanomaterial applications such as nanocomposites, paper, ink, purification, and catalysts. In addition to fundamental characteristics, presented in Table 1, some other optional characteristics of layered clay nanomaterials as shown in Table 2 are measured and reported subject to the agreement between sellers and buyers.