Nano-Clay Particle as Textile Coating

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Abstract-- **Clay particle is commonly any of group of important hydrous aluminum silicates with a layer (sheet) structure and very small size, as for example montmorillonite, which are often organically modified to render them organophilic and to enable their dispersion into a polymer. The result of such dispersion is a Nano composite comprised of nanoscale clay particles and a surrounding polymer. Important clay particles are Kaolinite,** Illite**, Bentonite, Chlorite and** Montmorillonite. The most used clay particle in textile coating is Montmorillonite: Chemically (Na, Ca) (Al, Mg)$_6$(Si_4O_{10})$_3$(OH) 6-nH_2O, Hydrated Sodium Calcium Aluminum Magnesium Silicate Hydroxide. **The aim of this study is to focus on functional properties of nanoclay coated textiles. Nanoclay particle can play an important role in flame retardant textile (cotton or polyester) coating. They can be acted as carriers for drugs, fragrances or other active agents and enable the controlled release of the incorporated species (bacteria, biocidal) which could find applications in skin care products. Recently, clays have become more important for various aspects of environmental science and remediation. Clay particle may absorb various pollutants including organic compounds (such as atrazine, trifluraline, parathion and malathion) and inorganic trace metals (such as copper, zinc, cadmium and mercury) from soils and groundwater which are mostly health hazards. As it is biodegradable and generated from purely nature occurring resources, has very less effect on the environment and human being.**

Index Term-- **Nanoclay, coating, montmorillonite, functional, environment.**

I. Introduction

Nanotechnologies leading to more sustainable and environmentally friendly alternatives to existing petroleum-based organic pigments, which face increasingly challenge due to their significant contribution to carbon emission and the gradual depletion of world crude oil reserve. There have been an increasing number of attempts in the development of coating based on clays from natural resources. Nanotechnology is understood as “research and technology development at the atomic, molecular, or macromolecular levels using a length scale of approximately 1-100nm in any dimension” including the ability to “control or manipulate matter on an atomic scale”. They created structures, devices or system must moreover “Show novel properties and functions because of their small size” [1]. In textile, like other field of technology, nanotechnology brings revolutionary changes during the last few decades. Nanoclay particles in textile coating are one of those modern technologies which bring revolutionary changes in textile finishing. Clay particle is commonly any of group of important hydrous aluminum silicates with a layer (sheet) structure and very small size, as for example montmorillonite, which are often organically modified to render them organophilic and to enable their dispersion into a polymer. The result of such dispersion is a Nano composite comprised of nanoscale clay particles and a surrounding polymer. They are usually used as products of weathering [3]

II. Important Clay Particles

Important clay particles are Kaolinite, Illite**,** Bentonite, Chlorite and Montmorillonite. The most used clay in textile coating is Montmorillonite: Chemically (Na, Ca) (Al, Mg) 6(SiO10)3(OH) 6-nH2O, Hydrated Sodium Calcium Aluminum Magnesium Silicate Hydroxide [8].

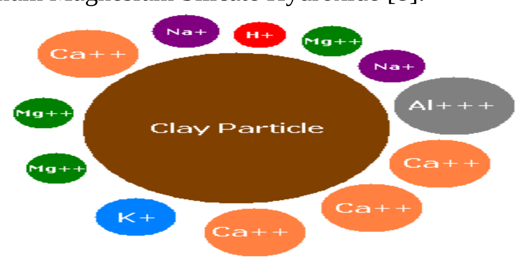

Fig. 1. Clay particle surrounded by different cations.

In the above fig 1, common clay particle surrounded by different cations are seen.
Some important properties of Montmorillonite clay particle is given below [8].

TABLE I
PROPERTIES OF MONTMORILLONITE CLAY [GRIMSHAW, 1980]

PHYSICAL CONTENTS	Properties
Unit cell molecular wt. (g/mol)	540.46
Density (g/ml)	(2.5) 2.3 to 3.0
Moh’s hardness @ 20 °C	1.5- 2.0
Appearance	White, yellow or brown with dull luster
Characteristics	In H2 O its volume expands up to 30-fold
DSC endothermic peaks, T (°C)	140, 700, 875
DSC exothermic peak (°C)	920

MMT swells in water more than any other mineral.

III. CONTRIBUTION IN TEXTILE COATING

The combination of hardness, scratch resistance and flexibility is a highly desired feature in many coating applications. This can be achieved through the introduction of unmodified clay, montmorillonite ($Na^{+}MMT$) in a polymer resin based on different textile material. Conventional coating characterization methods demonstrated an increase in the surface hardness, scratch resistance and flexibility but with the introduction of clay all coatings exhibited excellent chemical resistance and adhesion. Here in the fig 2, it is seen that nanoclay particle incorporated with hyper branched polymer applied on textile substrate [2].

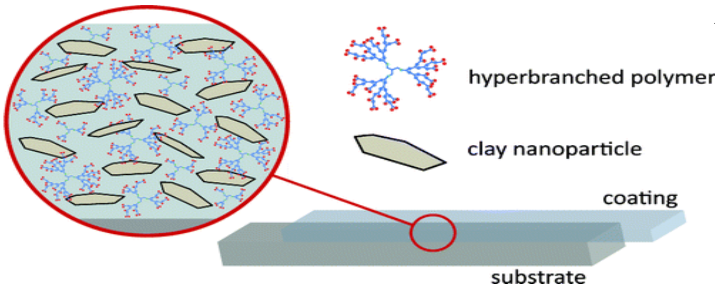

Fig. 2. Nanoclay particle incorporated with hyper branched polymer.

Moreover, Nano clay particle can play an important role in flame retardant textile coating. The exact mechanism of the combustion inhibition caused by the nanoclays is not yet known, but it is presumed that while the polymer matrix is burned and gasified during combustion, the incorporated nanoclays accumulate at the surface and form a barrier to oxygen diffusion, thereby slowing down the burning process [5].

Beside these nanoclays do slow down the burning process and enhance the char formation, but they have no effect on the ignition tendency and after flaming properties. The integration of nanoclay-composites alone is not sufficient to provide a fabric with reliable combustion protection. Recent research indicates that optimized properties can be achieved by combining the nanocomposites with low concentrations of conventional flame retardants. For the integration of the described nanocomposites into textile fabrics mainly two process pathways are possible. For both application pathways, nanoclay or nanoparticle is melt blended with the polymer material. Before this process, the nanoclays have to be modified by replacing the (sodium-) cations found between the clay layers with other, sufficiently organophilic ions to make the integration and dispersion of the nanoclays in the polymer matrix [5].

One possibility to incorporate these nanocomposites into textiles is by melt spinning them into yarns which can subsequently be knitted or woven to textile fabrics.

The second possibility is to apply the produced polymer-nanoclay composite as a coating to finished textiles, as for example cotton or polyester fabrics [5].

One of the most important polymer-nanoclay composite is Nylon-6 clay nanocomposites since 1990. In 1990 Toyota research institute prepared a true nylon-6 clay nanocomposite and they were so successful that they started using in their automobiles since then [3].

This composite contains clay nanoparticles and it may be hydrous, magnesium or aluminosilicates. Every clay mineral contains tetrahedral and octahedral sheets. Most common types of layered silicates used in nanocomposites are hectorite, saponite and montmorillonite (MMT). Among these MMT is widely used, because of its higher surface area. It is hydrous aluminosilicate clay with a 2:1 layered structure. Each layered sheet is 1 nm thick. Aspect ratio is 10-1000 and the surface area is 750 m^2 /g. When two tetrahedral sheets are combined with octahedral sheets 2:1 clay is formed and one tetrahedral with one octahedral, 1:1 clay is formed [3].

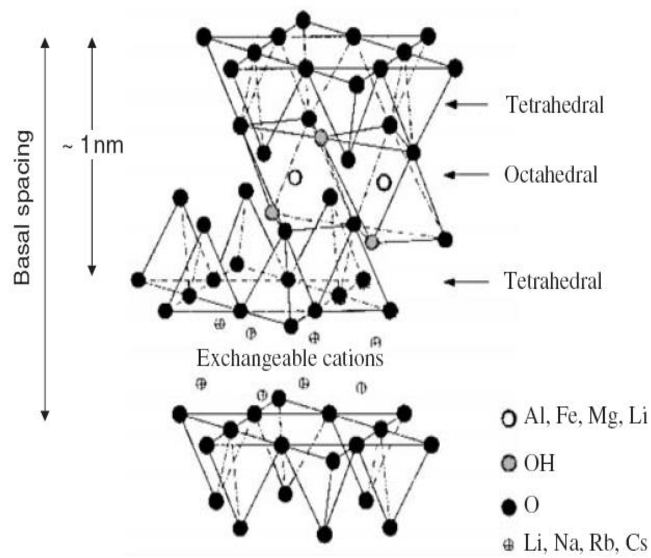

Fig. 3. Basic 2:1 clay minerals

The most commonly used technique for producing nylon-6 clay nanocomposite is In-Situ Polymerization. In this method polymer can be formed in between the intercalated sheets. Basic principle of this technique is the swelling of layered silicate in the liquid monomer using an initiator and some heat [3].

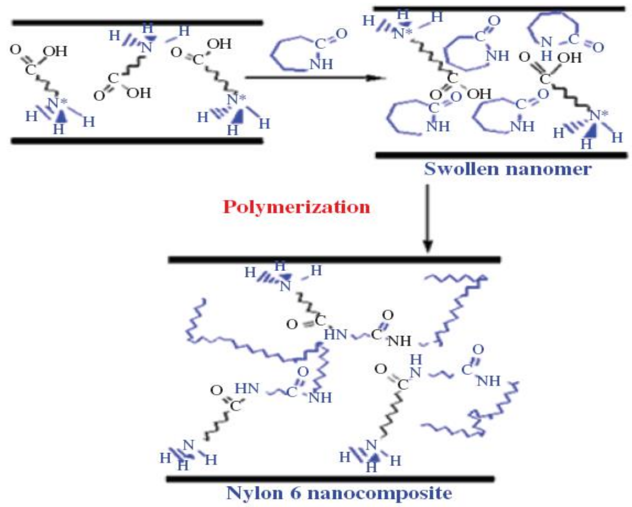

Fig. 4. Nylon-6 clay nanocomposite formed through in situ polymerization

There are some novel applications of nanoclay finishes. They can be used to produce fibers that act as carriers for drugs, fragrances or other active agents and enable the controlled release of the incorporated species. Research projects with the aim to produce antibacterial fabrics through the controlled release of a biocidal agent, used a montmorillonite-nanoclay as carrier for cosmetic jojoba oil substances to produce nylon fibers which could find applications in skin care products. The jojoba oil and nanoclays were incorporated into the polyamide-matrix by direct melt compounding, reports the possibility of producing fibers with controlled release of different agents (e.g. drugs, ethereal oils, or insect repelling fragrances) by including them into a SiO2 Nanosolcoating. Nanoclay particles combining with fire blocker materials (Nomex, Kevlar, glass fibre, Panox etc) can performing as very high quality flame retardants coating [5].

IV. Conclusion

Recently, clays have become more important for various aspects of environmental science and remediation. Montmorillonite can be compacted as bentonite blocks to serve as effective barriers to isolate radioactive wastes. Clay particle may absorb various pollutants including organic compounds (such as atrazine, trifluraline, parathion and malathion) and inorganic trace metals (such as copper, zinc, cadmium and mercury) from soils and groundwater which are mostly health hazards. As research continues, clay minerals are playing an increasing role in solving modern environmental problems.

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