ELEMENTIS

A global specialty chemicals company

Application Leaflet

BENTONE® organoclays

Improved properties in plastic composites

Key Benefits

- Improves flame retardancy
- Enhances barrier properties
- Optimized mechanical properties

Introduction

Organophilic clay materials have been commonly used for decades in the production of paints and coatings, adhesives and sealants as well as inks, lubricants, plastics, oil drilling applications and many others.

BENTONE® organoclay materials are based on either Bentonite or Hectorite, both minerals belong to the smectite group. This class of clay minerals is based on layered silicates comprised of outer silicate sheets sandwiching a central sheet of metal oxide. For bentonite clays, the central sheet consists of aluminum oxide containing some magnesium atoms. The magnesium atoms hold positions in the crystal lattice but have two positive charges rather than three charges in case of aluminum atoms. This charge disparity gives an ion exchange capability. The clay particles are irregular inshape and the particle size which can vary with different deposits, but their approximate dimensions are 800 x 800 x 1 nanometer.

Hectorite clay is different from Bentonite in that the central metal oxide sheet consists of magnesium oxide with some lithium substitutions. Another main difference is the size and shape of the platelets. Hectorite forms into an elongated platelet or ribbon shape with approximate dimensions of 80 x 800 x 1 nanometer (*Figure 1*).

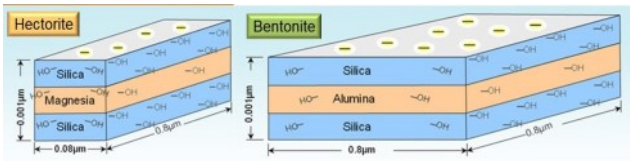

Figure 1: Mineralogy Hectorite and Bentonite

In the natural form the smectite clays face sides are negatively charged and saturated with sodium ions. To transform this hydrophilic clay into organophilic particles, it is necessary to modify the surface of their silicate plates with quaternary ammonium compounds. In this process, which is visualized in *Figure 2,* the sodium ions are exchanged by quaternary ammonium compounds.

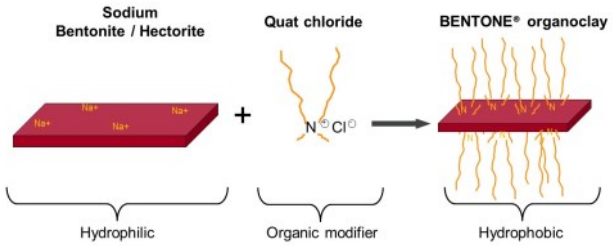

Figure 2: Ion exchange process

Various organic chemistries are used within the quaternary ammonium components in order to provide compatibility with various resins and plastics in accordance with their polarity.

BENTONE® organoclays are being compounded into the plastic in order to obtain the following properties:

Key properties

- Flame retardancy
- Barrier properties
- Mechanical properties

Activation and use

BENTONE® organoclays are typically used at levels of 3-8%. In order to provide the desired flame, barrier and mechanical properties. Sometimes concentrates with up to 50% loadings are being formulated which are in turn diluted back down to about 5% during compounding.

In order to obtain the highest performance it is key to achieve optimum delamination, or exfoliation, of the organoclays in the individual plastic systems.

In *Figure 3*, organoclay stacks prior to the full dispersion are shown.

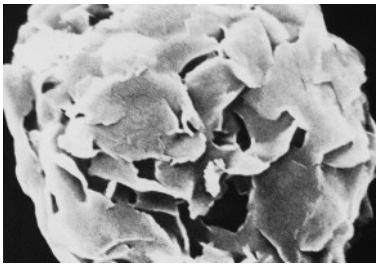

Figure 3: Organoclay stacks magnified 10000x

In the delivery form, the BENTONE® grades are powdered consisting of agglomerated platelet stacks.

The process required to fully disperse the platelet stacks and then to exfoliate the individual particles within the stacks requires a high degree of shear and may also require the addition of a compatibilizer (*Figure 4*).

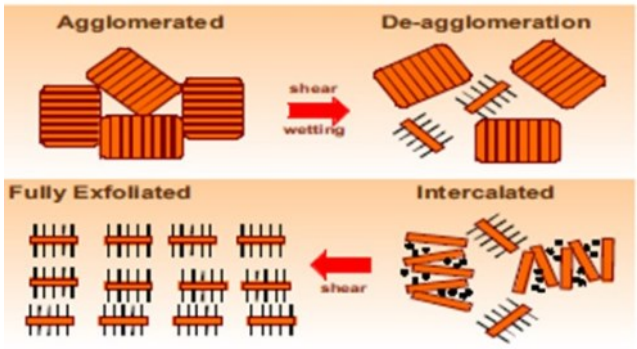

Figure 4: Exfoliation process

Although a certain amount of heat will accelerate the exfoliation process, too high temperatures (200°C for more than 25 min or 250°C for longer than 5 min) may result in a partial breakdown and decomposition of the organoclay resulting in poor compatibility with the plastic matrix.

Function

There are three major functions of the clays in plastics. These are flame retardance and an improvement of barrier and mechanical properties.

An explanation for the improved barrier properties is the so called “Turtoise path” theory (*Figure 5*).

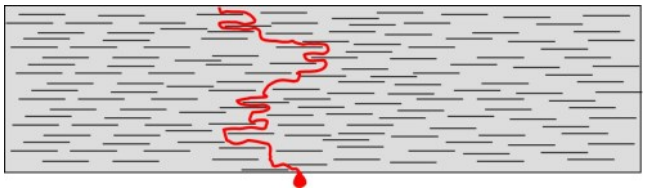

Figure 5: Visualization of turtoise path theory

The improved barrier properties are created by a high number of exfoliated and aligned organoclay platelets in the plastic matrix. Due to the oriented platelets, the way length for a passing particle through the specimen will be elongated.

The effect of oriented and exfoliated organoclay platelets imparts improved mechanical properties such as stiffness, strength and impact resistance.

The effect on the flame retardancy can be explained as follows and visualized in *Figure 6*.

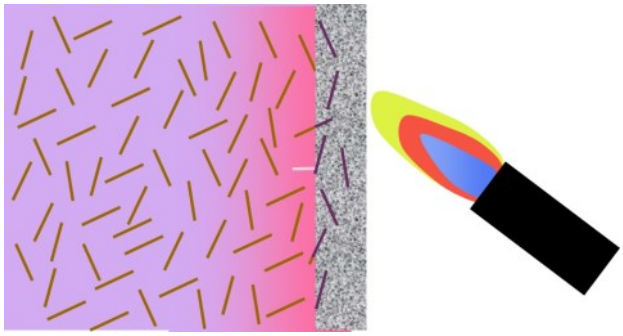

Figure 4: Effecting flame retardance

All organoclays act as a rheology modifier. In case the plastic is molten due to external heat e.g. in case of a fire, dripping is effectively prevented. Due to the previously described barrier function, less oxygen is penetrating into the plastic. Also evaporation of volatiles will be minimized. Furthermore, due to their inorganic origin, the platelets are not being consumed and remain active as barrier and reinforcing the layer during the exposure to the fire.

Appendix

Please refer also to our FINNTALC® and PLUSTALC® grades for plastic applications.

Product selection

The BENTONE® organoclay has to fit with the polarity of the proposed system. In the below selection table, the available BENTONE® grade are listed in accordance with a selection of potential polymers.

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