

## Nano Calcium Carbonate usage in Rubber and Plastics

### Why are Nano-fillers used?

Unlike traditional fillers, mainly used for cost reduction, nanofillers are performance-enhancing fillers used in relatively small amounts (2 to 5%) to provide substantial improvements in physical and other properties.

### Application of nanofillers - underlying principle

When a particle is downsized to nano scale, it becomes an agglomerate of limited number of molecules, and shows different surface properties than that from normal sized particles, as particularly indicated by the significant increase in specific surface area and surface energy.

- a) Nano sized particles (average diameter around 60 nano meters) form a very fine and homogenous distributed system in polymer matrix. As compared to micron size filler particles the nano size filler particles can occupy substantially greater number of sites in the polymer matrix. **The significant increase in specific surface area** of filler particles contributes to the enhanced physical property of the polymer matrix.
- b) Same weight of nano size filler will have 1000 times more number of particles (that are able to **occupy substantially greater number of sites in the polymer matrix**) as compared to micron size filler. Hence, to achieve same level of physical property in the reinforced polymer the dosage of nano size filler can be one fourth to one third that of micron size filler.
- c) Nano sized fillers increase barrier properties by creating a **maze or "tortuous path"** that slows the progress of gas molecules through the polymer matrix thereby substantially improving the gas / air permeability of the polymer.
- d) Nano sized fillers in polymer matrix substantially **improve surface properties** like gloss, surface finish, grip (friction) etc.

Nano Precipitated Calcium Carbonate ( $\text{CaCO}_3$ ) range in particle size from 0.06 microns or 60 nanometers to 0.15 microns or 150 nanometers in median particle size. This is an order of magnitude smaller than the so-called ground  $\text{CaCO}_3$  (GCC) or precipitated  $\text{CaCO}_3$  (PCC)

### **Use of Nano CaCO<sub>3</sub> in rigid PVC compound**

Incorporation of nano CaCO<sub>3</sub> in rigid PVC compound greatly enhances the impact behaviour relative to both unfilled polymer and modified PVC. Impact modifiers enhance the impact behaviour but their use at high levels adversely affects melt viscosity in addition to significantly increasing compound cost. Nano CaCO<sub>3</sub> used in conjunction can enable reduction in modifier levels with no adverse effects on physical properties and improved melt processing behavior.

Rigid PVC compounds containing nano CaCO<sub>3</sub> exhibit excellent gloss on extrusion and injection moulding. Nano CaCO<sub>3</sub> also improves scratch resistance, brightness and reduces whitening on flexure in PVC products. Moreover, its heat stability and dispersibility is excellent. It is preferable to use twin-screw extruder in order to achieve proper dispersion of filler.

It is well established that incorporation of Nano CaCO<sub>3</sub> in rigid PVC compound formulation increases notched impact strength (entailing lower usage of costly acrylic & CPE impact modifiers) as well as improves tensile strength, elongation at break and flexural modulus as compared to formulation without nano CaCO<sub>3</sub>.

### **Use of Nano CaCO<sub>3</sub> in Rubber products**

Nano calcium carbonate can be used as reinforcing filler alone or with other fillers such as carbon black, precipitated silica etc. to achieve effect of reinforcement and improve processing as well as end product performance. Use of nano calcium carbonate even in low dosage in rubber compounds substantially improves physical properties like tensile & tear strength, elongation at break, abrasion (wear) resistance, flex cracking, ageing resistance etc.

Moreover, use of Nano calcium carbonate can improve surface properties like gloss, surface finish, grip etc. It also helps in improving barrier properties like gas / air permeability of the rubber product and is suitable for light colored products. It has been found that Nano CaCO<sub>3</sub> may be used to partly replace costly precipitated silica filler in rubber compounds. The undersigned had carried out trials with Nano CaCO<sub>3</sub> in rubber compounds way back in 2005 and published the results in various journals and technical conferences.

### **Other Uses of Nano CaCO<sub>3</sub>**

They serve as rheological additive and cost-reducing filler in lithographic / offset inks

They are ideal for Gravure inks which require very low abrasion fillers

They are used in epoxy adhesives for improving rheology and filling

De-tackifier and mold release for thin gauge surgical & medical gloves

Nucleating agent in emulsion polymerization

Used in high performance, long-lived automotive and construction sealants

We can provide complete technical assistance regarding use of Nano CaCO<sub>3</sub> in rubber and rigid PVC compounds for various end use applications from development to actual use in bulk quantities.

Best regards,

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