Nano from nature

Siliceous earth - a fine functional filler with a special structure.

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Neuburg siliceous earth is a naturally occurring nanostructured filler material, whose specific particle structure allows to impart coatings with very good mechanical and chemical resistances, while being easy to incorporate into the formulation. The extraction of natural mineral fillers has been pursued for more than two hundred years. During this period, the requirements placed on such fillers, and consequently the products themselves, have changed considerably. In particular with respect to product consistency, purity and functional properties, functional fillers have to respond to ever higher and more stringent demands. Also, in connection with innovations in paints and coatings, "nanotechnology" is mentioned very often these days. Quite frequently in this context, products and materials are proposed which, in view of a missing generally accepted definition, do not really deserve this designation. In theory, an ultrafine natural mineral filler with a mean grain size below 1 µm might be called a nano filler, implying 'nano from nature'. In this respect, Neuburg Siliceous Earth, with primary particles way below 500 nm in size would easily fit into this category. But although there are no general rules yet, in the scientific literature it is generally accepted that only products with grain size distributions below 100 nm should be considered as nano materials. The majority of natural mineral fillers does not meet such a requirement.

The particle structure and morphology counts

From a technical application standpoint, however, it is often not of critical importance whether or not a material can be called a nano filler. It is rather the total (eventually composite) particle structure observed on the nanometer scale, which gives rise to specific technical application effects in coatings. This refers not only to dispersion, stability and rheology, but also to flattening, elasticity, hardness, wear resistance and corrosion protection.

The particle structure of Neuburg Siliceous Earth offers an outstanding example of such a situation. Thus Figure 1 shows a scanning electron microscope (SEM) photograph of "Sillitin Z 86". The image covers an area of about 12 µm width. Distinctly visible is the natural fusion of the kaolinite particles of rather conventional appearance with a corpuscular quartz. One particular characteristic of Neuburg Siliceous Earth lies in the fact that this corpuscular quartz consists of a high number of aggregated, partly dispersible primary particles which rarely exceed a size of 200 nm. Another is that in this functional filler the kaolinite is found in a state, which indicates that it has already been subjected to extensive delamination.

Low abrasivity

The combination of these two particle phenomena, as created by nature, gives rise to a number of beneficial properties in paint and coatings systems, which very often cannot be matched by other natural or synthetic fillers, including the so-called nano fillers - not even taking cost aspects into account. As another advantage, because of its fine particle size and the rounded grain shape of the quartz portion, Neuburg Siliceous Earth only exhibits very low abrasivity towards dispersion aggregates and processing equipment (Figure 2).

Outstanding mechanical and chemical resistance

In view of the mineral hardness of the quartz, the coatings formulated with Neuburg Siliceous Earth ("Sillitin" or the surface treated "Aktisil") offer outstanding abrasion and scratch resistance, which makes it particularly suitable for use in wear resistant parquet floor coatings. In addition, its flattening action allows to eliminate additives otherwise used for such effects.

In addition, the fine particle quartz also has a positive influence on the resistance against chemicals, which is why the siliceous earth is eminently suitable as a functional filler for use in chemically resistant and anti-corrosion coatings.

The natural combination of corpuscular quartz and lamellar kaolinite ensures rapid incorporation and excellent dispersion - in particular also in aqueous systems - along with a basically low sedimentation tendency (Figure 3). If a sediment is formed at all, it will be easily redispersed. This way, Neuburg Siliceous Earth can also serve as a functional filler to 'stabilize' coarser particle size fillers.

The good integration of the filler into the polymer network leads to excellent mechanical properties. This effect can be further enhanced by a surface treatment of the filler particles, e.g. with silanes. Thus, the compatibility with the polymer is increased, which leads to outstanding rheological properties while retaining the good mechanical characteristics and excellent resistance against abrasion and chemicals.

These numerous effects confirm that the properties of coatings cannot be improved with synthetic nanofillers only. In fact, nature also has developed some "natural nano-structured fillers" which make it possible to develop high quality coating formulations with very good performance.

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Figure 1: Electron microscopic view of Neuburg Siliceous Earth showing corpuscular quartz and lamellar kaolinite particles.
Figure 2: Abrasivity of different quartz, mica and siliceous earth filler materials
Figure 3: Sedimentation behaviour of Neuburg Siliceous Earth (left) compared to conventional silica filler