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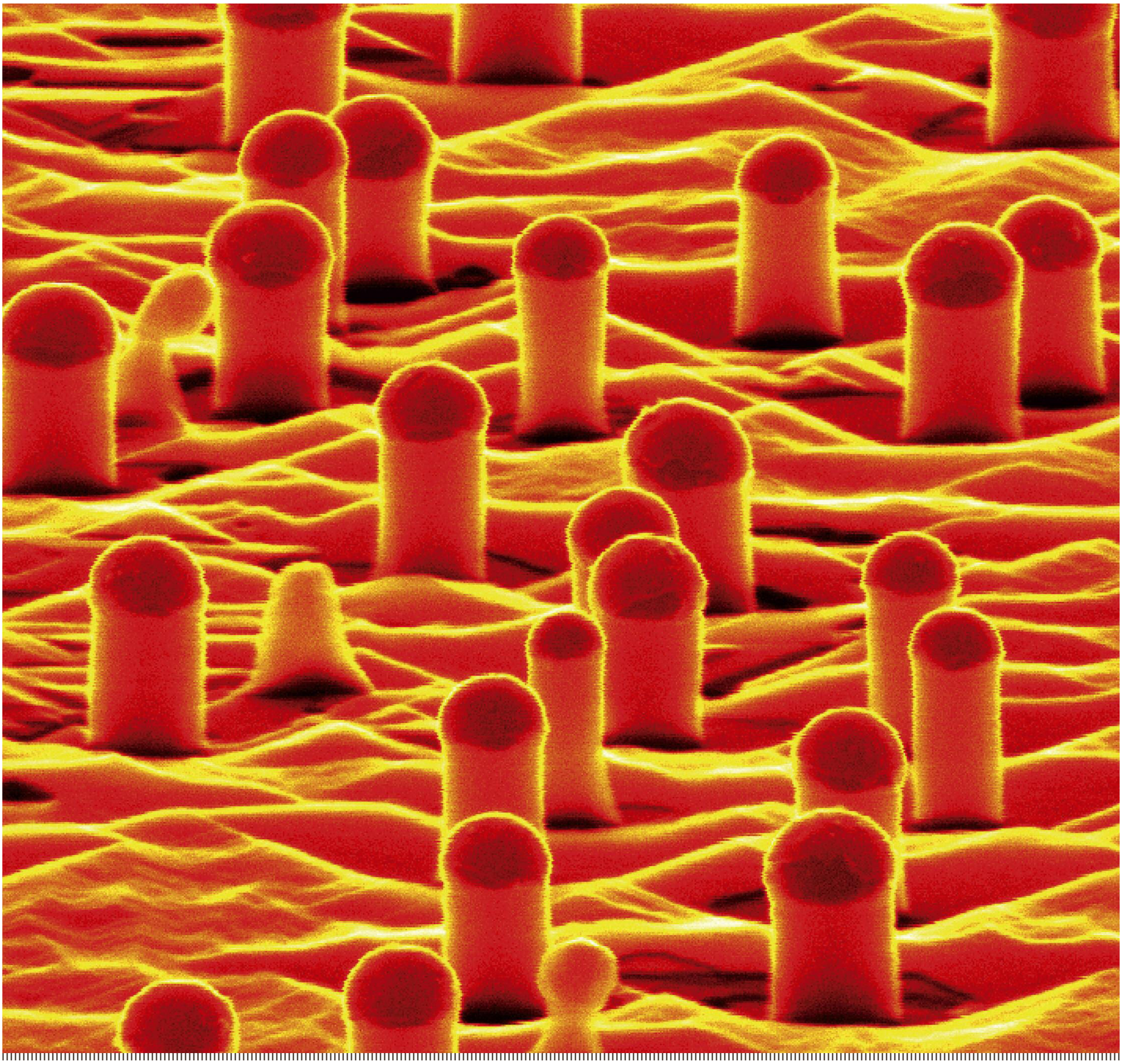
Nanotechnology: Small particles hit the big time



Pigments and fillers add colour to our lives.

Pigments and fillers make our everyday lives more colourful

All things nano under the sun?

What do things like automotive paints, pottery, paper, or roof tiles actually contain? Well, two of their components are pigments and fillers. Both make life easier and more colourful – and they've been doing so for a long time. That's why the Verband der Mineralfarbenindustrie (the German association of producers of pigments and fillers etc), is arguing that the EU definition of nanomaterials should expressly exclude traditional pigments and fillers. Otherwise practically all coloured products would be classified as nanoproducts.

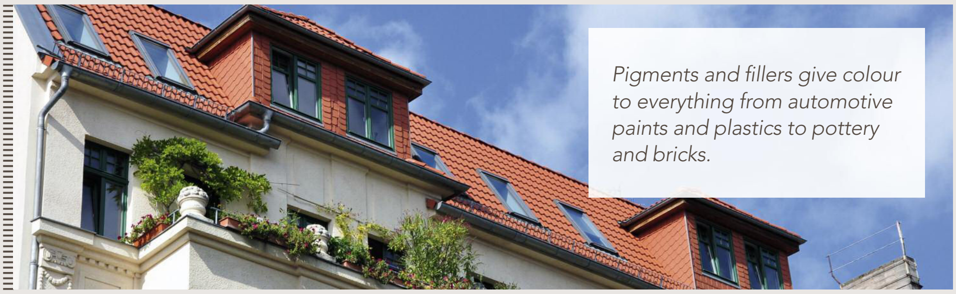
Pigments and fillers are not new: earth-based colourants have been detected even in cave paintings. And in ancient Egypt, the soot of oil lamps was used to make black pigments of high opacity and stability – ideal for putting clear black writing on papyrus. It just so happens the Egyptians didn't know that the soot they were using contained nanoparticles. The glassmakers of the Middle Ages fused tiny quantities of gold into the glass when creating church windows. But they had no way of knowing, back then, that they were in the process of creating clumps of gold atoms between five and 30 nanometres in size. At this scale, an important property of gold changes: instead of producing a yellow-gold colour, the windows gleam with a red hue.

To this day, pigments and fillers can be found in everything from automobile paint to bricks. They satisfy functional, decorative, protective and safety requirements. Colour effects also influence the purchasing behaviour of product users.

The colour is a result of the interaction of the pigments with visible light. Things like glass or concrete, for example, only appear coloured to us because pigments are added. Moreover, the numerous hues that are possible can only be achieved by mixing various pigments. Pigments must therefore be distributed finely and uniformly in order to develop the best-possible effect.

In an ideal world, the crushing or dispersion necessary to colour paints and plastics would always involve identically sized particles. But this ideal situation almost never arises. Instead, one achieves more or less narrow particle-size distributions – as is often the case in nature. Inadvertently, a certain proportion of very fine nanoparticles is thus always created too. These usually don't occur unbound, however. Instead, they cluster together to form larger structures called "agglomerates" or "aggregates". In the final products, all pigment particles are firmly bound in the matrix used in each particular case; they are not present in an unbound form.

In addition, there is no danger of any contamination occurring at the workplace, because pigments and fillers are normally manufactured in closed systems. Frequently, at an early stage – for example, during the production process – the powders are incorporated into a paste or, alternatively, they are dispersed in a liquid in order to prevent the formation of any dust. Closed systems or dust extractors are likewise used when powders are transferred into different containers.



Pigments and fillers give colour to everything from automotive paints and plastics to pottery and bricks.

What are pigments and fillers?

Pigments are solid particles. A pigment can be coloured, black, white, or fluorescent. Unlike dyes, they do not dissolve in the medium in which they are used, whether it be a coating or a plastic, for instance. A distinction is made between organic and inorganic pigments. The properties of a pigment that impart colour arise from the interaction of its particles with visible light.

The specific properties needed in pigments differ from one application to another. These properties relate to features such as ease of distribution, colour intensity, light and weather-fastness, mechanical stability, hue, and opacity. These characteristics depend on the chemical composition of the pigment as well as the sizes and arrangements of the pigment particles.

Fillers: particulate and solid
Fillers usually consist of very small, solid particles that are likewise insoluble in the application medium. They are used in plastics and coatings primarily because of their technical properties; the colour they impart is usually only a secondary criterion.

It is only possible to breathe in pigment powder during production and processing when a closed system is not being used. If non-toxic pigment powders are breathed in, their effect is the same as that of any other particulate matter that is only slightly soluble. If large concentrations of such particulate matter are breathed in over a very long period of time, health risks cannot be ruled out. The possible consequences include coughing, for instance. But lung function can be impaired too. To protect their employees, companies must thus observe the protective measures stipulated in the relevant safety data sheets and always make sure that the levels of particulate matter at the workplace are kept below the appropriate thresholds.

RESEARCH PROJECT OF TU DRESDEN

The end consumer usually has only indirect contact with pigments and fillers – normally through objects that are coated or coloured with them. In such cases, the fine or nanodispersed particles are part of a solid matrix or a liquid preparation. There is thus no possibility of end users or consumers being exposed to them. The results of a research project titled "Risk assessment concerning the release of pigment nanoparticles into the environment at the end of the life-cycle process (FRINano)", which was conducted by the university TU Dresden, confirm this assessment.

Under controlled conditions, the scientists exposed coatings and plastics containing various fine-particle organic and inorganic pigments to artificial weathering effects, thereby simulating approximately five years of typical weather conditions. They then subjected the samples to a variety of mechanical stresses – such as suction, rubbing, and abrasion. The results show that pigmented coatings and plastics are more resistant to weather effects and wear than unpigmented varieties. An additional health risk due to the possible release of pigment nanoparticles from coloured objects was ruled out. That is the current state of our knowledge as far as safety research is concerned.

But what's the situation when it comes to regulatory classification? The recommendation of the EU Commission in autumn 2011 concerning the definition of nanomaterials has significant consequences for pigments and fillers. According to that recommendation, almost all colour pigments and fillers available on the market could be defined as nanomaterials, even though they have been in use for a very long time. In fact, a nanoproduct register would basically have to list almost all everyday objects – an obvious absurdity. It would make more sense to exclude traditional pigments and fillers from the legal definition of nanomaterials. Subsequent legislation should take into account whether or not pigments and fillers are tightly bound to a matrix or paste.

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Reader service: For more information, see the brochure *Nano – The Measure of All Things*, available at no charge from the Verband der Mineralfarbenindustrie: info@vdmi.vci.de.