# NANOMATERIALS FOR ARCHITECTS AND ARCHITECTURE

TO INTRODUCE NANOMATERIALS INTO ARCHITECTURE, ARCHITECTS MUST FIRST BE ATTRACTED TO THE NANOWORLD. INNOVATION-DRIVEN MATERIALS AND PRODUCTS SERVE AS A TOOL FOR ACHIEVING GREEN CONSTRUCTION, WHICH IS NOW ON THE FOREFRONT OF ARCHITECTURAL DEBATES. NANOMATERIALS DO HAVE A HUGE POTENTIAL, BUT THIS POTENTIAL IS YET TO BE REALISED, AND ARCHITECTS ARE YET TO ENGAGE FULLY WITH WHAT IS AVAILABLE, THEREFORE AS A BASIC PRINCIPLE, AN UNDERSTANDING OF THE POSSIBILITIES OFFERED BY NANOTECH IS ESSENTIAL FOR ARCHITECTS, PLANNERS AND PROJECT DEVELOPERS.

**SYLVIA LEYDECKER** DISCUSSES HOW THE ARCHITECTURE WORLD NEEDS TO ADAPT TO THE NEW OPPORTUNITIES OFFERED BY NANOTECHNOLOGY PRODUCTS.

***Nano* has become a word which isn't as unheard-of in the architectural world as it was a couple of years ago. Nevertheless, what it actually means and what it can be used for is still almost unknown in the architectural community.**

Having little substantial information, nebulous ideas are formulated, fact and fiction are mixed up in several web-forums or the whole topic is reduced to the catchy name "Lotus effect". The main problem seems to be a lack of information due to the huge gap between the world of science and the world of architecture. Chemical formulas, curves, diagrams, hard to comprehend vocabulary, underexposed pictures of poor-quality architecture, accompanied by badly designed layouts isn't the appropriate way to attract architects at all. Much better is understandable writing, images of high-quality built examples, and at least an acceptably designed layout able to fulfil aesthetic demands. (Incidentally, exactly this gap is filled by the book I've written: "Nanomaterials in Architecture, Interior Architecture and Design"!)

Despite these problems with its mode of communication, the role that nano is already playing is getting bigger with the increase in use of smart materials. On one hand we're still building with brick and mortar, which sounds quite medieval, or we use concrete, which was invented by the Romans. On the other hand we are building smart facades, constructing ambitious buildings composed of glass and membranes - today's technology for the future.

Omnipresent today is the term "sustainability". This is exactly what we have to achieve: today, now and here, not later, we have to build for our future on this planet. With the help of nanotechnology, it is possible to do this. Nano-science definitely offers the chance to solve our global climate problems, answering the questions which governments have been struggling with up to now. If there is a single reason to use nanotechnology in architecture, it is definitely because of energy efficiency and sustainability. Ecological and economical advantages are offered by nanotechnology, which cannot be ignored as a way to reduce climate change. This is more important now than it ever was. Climate protection pays off, this is why in the long run ecology in architecture is also economical. In the meantime very cheap material is still used in construction, for the sake of quickly gained and maximized profits.

Nanotechnology as progressive science is today's answer for the future, it will change the future of architecture to the use of advanced construction and materials, which help to reduce carbon emissions. At least, its promise

for the future of our planet offers a chance which we simply do not have otherwise.

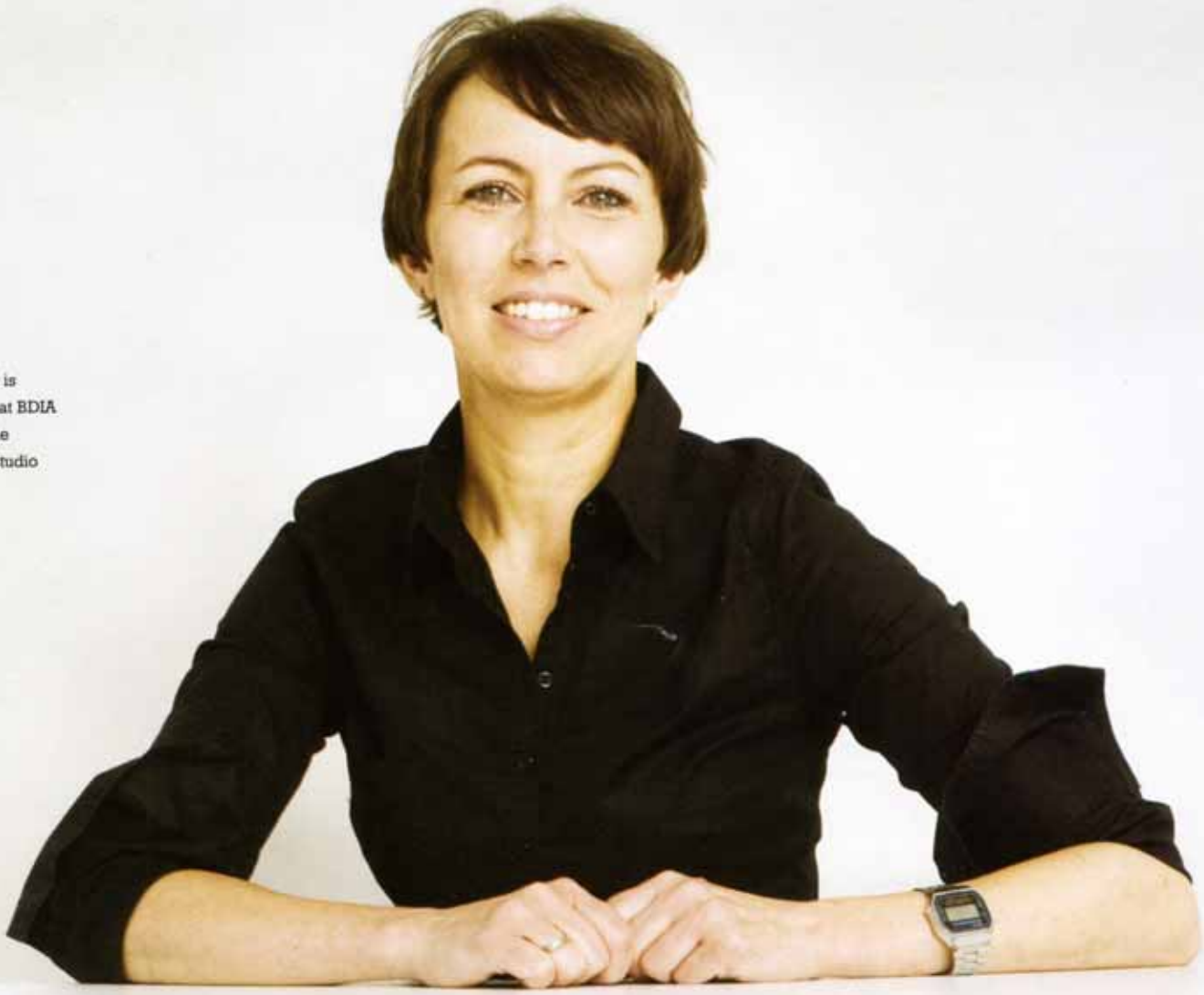
Fundamentally there are three ways for architects to approach the use of material. Traditionally, 'real' material, such as stone or wood, is used. This approach is favoured by those architects who tend to prefer authenticity.

Second, there is a mass of fake-materials which are used for cost and maintenance reasons. Artificially designed fake surfaces, such as wood-effect plastics, laminates etc. are continually perfected and are more visible and increasingly difficult to differentiate from the original and identify as fake. Even patina is forged, whereas – strangely enough - at the same time, a real patina would not be accepted by clients.

Third, there is emerging nanotechnology: emancipated from the underlying material, properties of functional surfaces are invisible and can be completely different. Another approach is offered by nanocomposites, providing completely new materials and the optimization of existing products.

**Easy Clean Surfaces**

There are several nanofunctions already implemented in the market and comparatively well established. Self-cleaning surfaces are at the forefront: The well known Lotus-Effect ®, despite its popularity, isn't really present in the market. The scientist Barthlott, who investigated the effect, was clever enough to not only find a catchy name, but to protect it as well. Nevertheless its micro-rough surface can't stand mechanical treatment, and so the licence is given to only a few building products such as paint. Because of its hydrophobic effect, it is quite often confused with easy-to-clean surfaces, which show the same effect but are different in function. Easy-to-clean surfaces have started to be quite common in the sector of sanitation and are used for shower-glazing, toilets, wash-basins and are now found in other products as well. Photocatalytic self-cleaning surfaces, mostly glass and paint, also membranes, are quite common worldwide. These surfaces are, contrary to the above-named, not hydrophobic but hydrophilic. Water runs off in films and loose dirt is easily washed away. All these surfaces are in the strict sense only, almost selfcleaning, which means cleaning cycles are considerably longer, but cleaning is still required. That cleaning is needed at all, causes difficulties because of expectations of the contrary. Antibacterial functions are now the most interesting function for the healthcare sector. You can find tiling, flooring, light-switches, handles, paints – a broad range of applications, but sometimes in a very limited product range, for instance in just a single model. Anti-fingerprint protection on stainless-steel or coloured glass, is perfect for interior use. Ultra-high-performance concrete (UHPC) is one of the most exciting new developments, because of its strength, provides elegant and thinner construction, needing just the minimum material.



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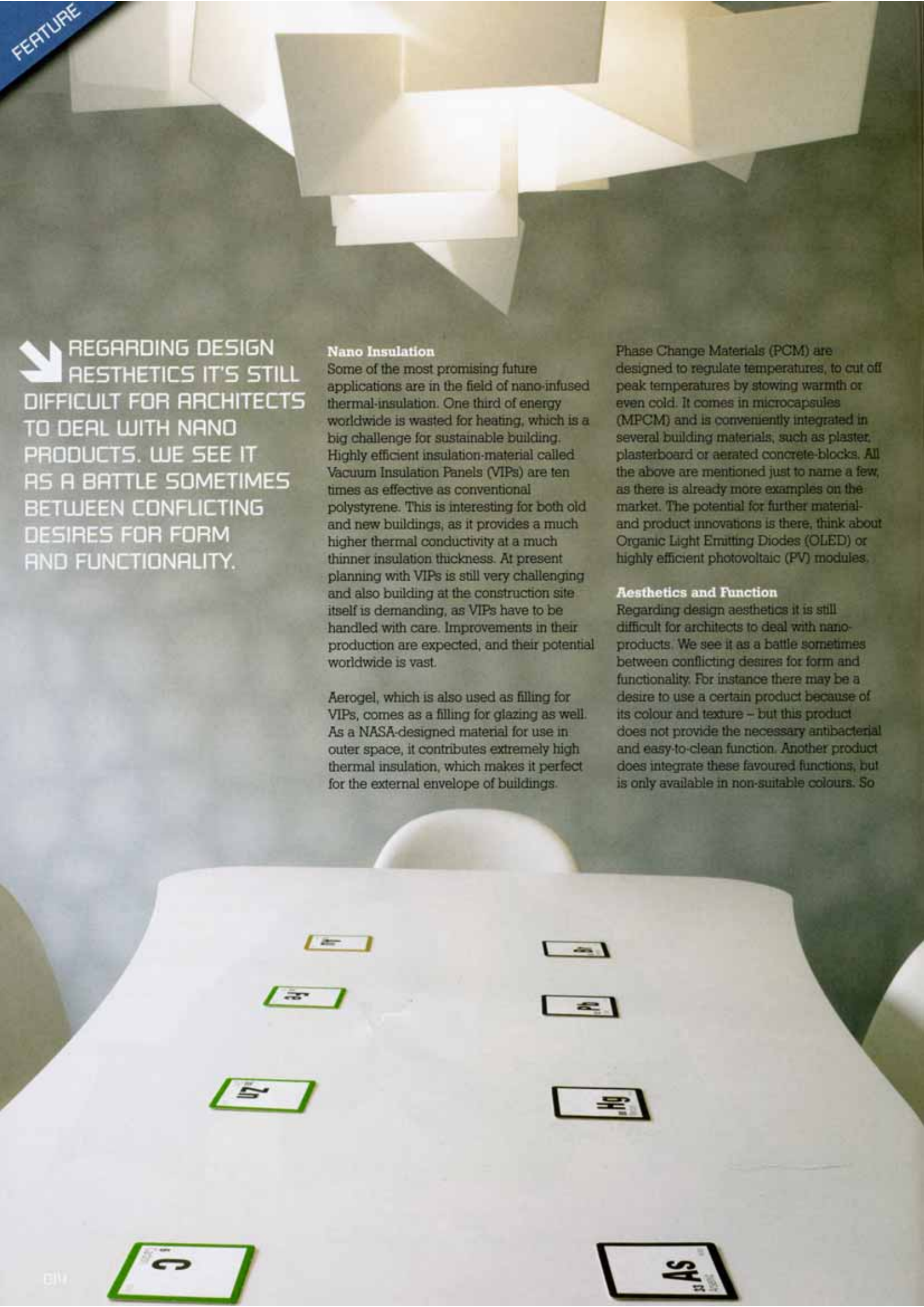

REGARDING DESIGN AESTHETICS IT'S STILL DIFFICULT FOR ARCHITECTS TO DEAL WITH NANO PRODUCTS. WE SEE IT AS A BATTLE SOMETIMES BETWEEN CONFLICTING DESIRES FOR FORM AND FUNCTIONALITY.

**Nano Insulation**

Some of the most promising future applications are in the field of nano-infused thermal-insulation. One third of energy worldwide is wasted for heating, which is a big challenge for sustainable building. Highly efficient insulation-material called Vacuum Insulation Panels (VIPs) are ten times as effective as conventional polystyrene. This is interesting for both old and new buildings, as it provides a much higher thermal conductivity at a much thinner insulation thickness. At present planning with VIPs is still very challenging and also building at the construction site itself is demanding, as VIPs have to be handled with care. Improvements in their production are expected, and their potential worldwide is vast.

Aerogel, which is also used as filling for VIPs, comes as a filling for glazing as well. As a NASA-designed material for use in outer space, it contributes extremely high thermal insulation, which makes it perfect for the external envelope of buildings.

Phase Change Materials (PCM) are designed to regulate temperatures, to cut off peak temperatures by stowing warmth or even cold. It comes in microcapsules (MPCM) and is conveniently integrated in several building materials, such as plaster, plasterboard or aerated concrete-blocks. All the above are mentioned just to name a few, as there is already more examples on the market. The potential for further material- and product innovations is there, think about Organic Light Emitting Diodes (OLED) or highly efficient photovoltaic (PV) modules.

**Aesthetics and Function**

Regarding design aesthetics it is still difficult for architects to deal with nano-products. We see it as a battle sometimes between conflicting desires for form and functionality. For instance there may be a desire to use a certain product because of its colour and texture – but this product does not provide the necessary antibacterial and easy-to-clean function. Another product does integrate these favoured functions, but is only available in non-suitable colours. So

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the architect must resort to using the first product, knowing at the same time that it could have been a better, updated version. The winner is always the product which provides both – aesthetically and functionally, in the advanced sense. Hopefully these products are becoming more available, as innovations are always on the producer's roadmap.

**Marketing Nano in Architecture – Benefits and Pitfalls**

It is difficult for architects to get to know what they are actually dealing with in the products and materials they plan with. Depending on changing marketing strategies companies may choose to communicate or conceal the use of nano in their product.

Three ways of marketing "nano" actually occur:

*1)* The use of nanotechnology is communicated in an offensive way, as a response to a demand for innovation, and at the same time demonstrate an innovative approach and market leadership. Just to attach the word "nano" isn't quite enough to convince architects, it is also necessary to communicate its purpose, its use and the advantages of the specific material or product.

*2)* Contranly, the use of nanotechnology in a product or design is not communicated at all, and furthermore, even concealed, because of a fear about negative "risk"-reaction. This is thoroughly understandable, but it can't be allowed to be the case because of two reasons: on one hand the consumer wants just be informed what it is all about (if it's not "nano" it can't work ...) on the other hand it's just not possible, as there seems to be a stigma about using NT.

*3)* The product is labelled "nano" to take advantage of the term nano as a futuristic brand, while in reality it has nothing to do with nanotechnology at all. All-in-all, the strategy of truth is the better one, as firms who pretend to have or claim not to have but in fact do, lose their reliability and reputation. How can one believe what else they are saying?

As such, for architects nano is quite difficult to deal with, especially when they don't know anything about it and are unable to ask the right questions to the right people. The confusion is confounded because there isn't a precise definition of "nano" and it is sometimes difficult to find the appropriate contacts with the knowledge to help - so better stick to technical departments or even labs of the producing firms.

Innovations are hard to implement into the notoriously conservative field of architecture. Construction, with the help of something new, always requires a readiness to assume a risk. Not only by the architects who plan the buildings, as they are the ones to be liable for a long time, but also by the construction firms that realise their ideas. They also might not win a tender because of the higher prices incurred by the use of more expensive nano-products. This will hopefully change in the future, as the use of nano results in lower prices in the long run. Clients should be fully informed as well, as they can be the ones to start with the implementation of clever construction and materials. There is still a lack of communication from architect to client to firms, which creates a barrier for innovation. There are built references around the world which show that nano-products work, and do not belong to the realms of science fiction.

**Some Unquestionable Nanobenefits**

For clients dealing with public private partnerships (PPP) and facility managers, nanotechnology in architecture is a "do not ignore" topic, as it reduces maintenance costs. Energy savings and reduced cleaning are two of the main factors, which show up in lower maintenance costs and which can be a huge benefit for operator to gain profits.

More efficient production-processes and cost-efficiency is integrated in the lifecycle-chain of a product. Directly, for instance, scratch resistant lacquer helps to reduce production-steps whereas indirectly highly efficient insulation conserves energy, needs less material and in consequence less transportation and reduces carbon emissions. Reduction in the use of energy, minimum use of raw materials and reduction in the waste of resources forms a powerful argument for using nanomaterials in architecture. As architectural discussion today is all about sustainability, especially in the context of worldwide property ratings by labels such as BREEAM, LEED, DGNB, innovation-driven and highly-effective materials are of substantial interest. The use of nanomaterials is an effective tool for green building.

**The Way Ahead**

In the last few years, there has been an enormous hype about materials in the fields of architecture and design. Books about materials have popped up everywhere, accompanied by the installation of several material archives aimed at architects, designers and also producers. Materials are at a certain point of the supply chain – it's nice to get to know the material, but it's also important is to get to know the real people behind it. At this point, it is necessary to see the importance of working together through several fields. Scientists, producers, architects – they have to work together to form the materials which are needed, and the products which are wanted. Scientists, producers and creative people have to communicate with each other and work together, regarding the long chain from raw material to successful products, to selling on the market.

Finally, for architects it's not a "must" but a "nice to have" knowledge about nanotubes and buckyballs as icons of the nano-world. A very promising way to get to know buckyballs, is the American architect Richard Buckminster Fuller, who is well-known in architect's circles. His impressive geodesic domes, self-supporting cupolas, are characterized by Buckyball-Structures which are adored. Almost unknown is that before him, German architect Bauersfeld realized these structures, but he failed to label it in a handy way, which again shows the importance of communication.

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*She is the author of* ***Nanomaterials in Architecture, Interior Architecture and Design*** *published by Birkhauser. For more information, visit www.100%interior.de*