Nanotechnology

**No longer the stuff of science fiction, nanotechnology has arrived and is here to stay. Economists with the National Science Foundation in the USA predict a trillion Dollar market for nano-products by the year 2015.**

# Nanotechnology Smart Surface Treatments

## How it works--in simple terms.

**Nanotec-USA**

(866) 626-6187

sales@nanotec-usa.com
www.nanotec-usa.com

## TABLE OF CONTENTS

## INTRODUCTION

As we move into the new millennium, research into manipulating and controlling things on a nano sized scale is well underway.

Already it has begun yielding solid technological benefits, and there are a great many more waiting in the wings.

Even those not tuned into the high-technology scene no doubt had heard about nanotechnology.

The nano-world has always shaped the visible world around us, and now we are venturing into that frontier to study it and learn how to use it to our advantage.

Nanotechnology is not a single industry but a scale of engineering involving matter between 1 and 100 nanometers. Instead of one new phenomenon, like the Internet, nano offers new possibilities for thousands of materials that already exist.

How do these tiny molecules create big new products?

Most of the early advances in nano will improve what we already have. A tiny dose of nanoparticles and a self assembling process can transform the chemistry and nature of far bigger things.

Nanotec-USA is using most advanced nanotechnology in products for everyday use and application.

With products popping up by the dozen using and the term “Nanotechnology “ it seems necessary to point out a few technical characteristics to illustrate what is different in the products from Nanotec-USA.

## When is something new really new?

Imagine this: You dump a pile of Lego pieces on the floor, and they start bouncing around, sometimes snapping together. Gradually, elaborate Lego structures form: bridges, buildings, vehicles. All this happens without any human intervention.

It sounds like magic, but something very much like this is constantly occurring at the molecular scale in every cell in your body. Called self-assembly, it's the spontaneous formation of ordered structures from smaller parts.

## Self assembling of Nanoparticles

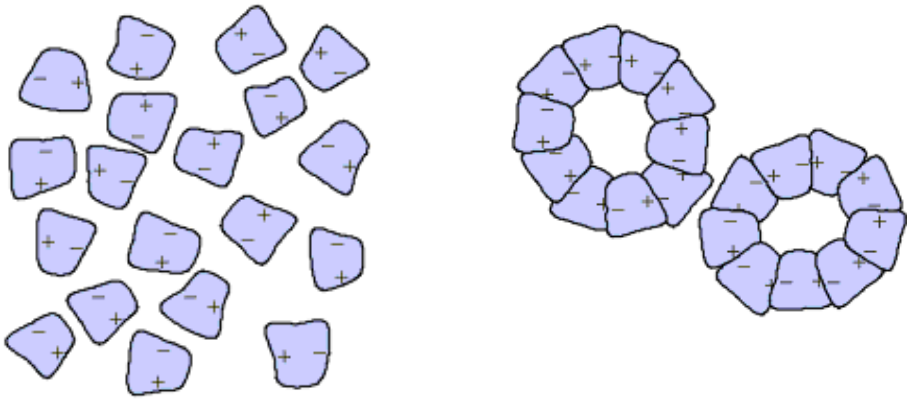


**Figure 1: Self-assembling rings: before. Wedge-shaped monomers, with positive and negative charges, start out in disarray, end up as rings. Put this ring on top of each other and you end up with a (carbon) nanotube.**

Nanoparticles of a wide range of materials - including a variety of organic and biological compounds, but also inorganic oxides and metals can be processed using chemical self-assembly techniques. These techniques exploit selective attachment of molecules to specific surfaces and self-ordering principles as well as well-developed chemistry for attaching molecules onto clusters and substrates. The molecular building blocks act as parts of a jigsaw puzzle that join together in a perfect order without an obvious driving force present.

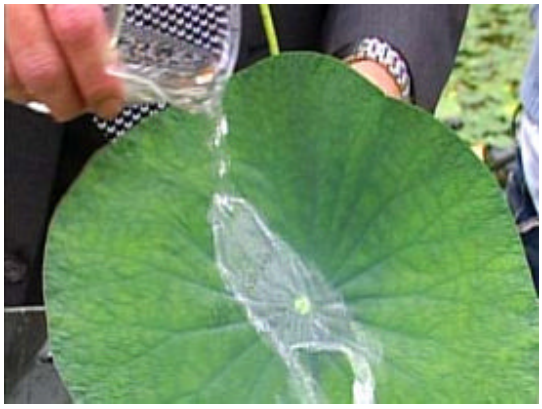
## A FEW EXAMPLES OF NANOSCALE SELF ASSEMBLED SURFACE STRUCTURES

How Mother Nature does it:

The leaves of the lotus are extremely hydrophobic and water-repellent. Not only they are water-repellent, they are also self-cleaning. After a shower of rain they immediately appear dry and clean, since water droplets rolling off a lotus leaf carry away contaminants, cleaning the surface. The lotus effect is based on the surface roughness caused by different microstructures combined with hydrophobic properties.

The air pockets, created by the valleys, result in an even greater water-repellent surface. We understand how it works on the leaf surface – but how do you make and apply these properties to another surface?

The wet ability of a smooth, easily wettable surface is even improved through roughening. On a smooth, hydrophobic surface, roughening can result in a super-hydrophobic surface. (contact angles above $150^0$)



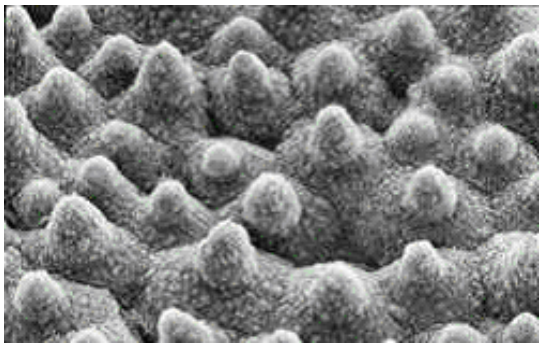


**Figure 2: Nano-structure of a Lotus leave**

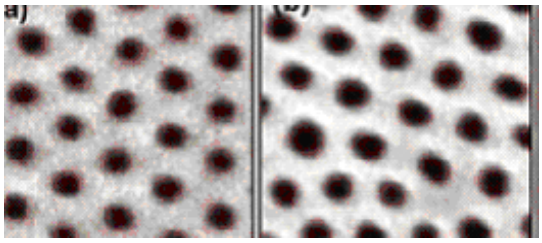


**Figure 3: Self assembled surface structure, IBM Research**

To transfer the Lotus-Effect into coatings, it is necessary to create a hydrophobic surface with very low surface tension, along with the appropriate micro-structure.

## Sol-gel Process and Self Assembling

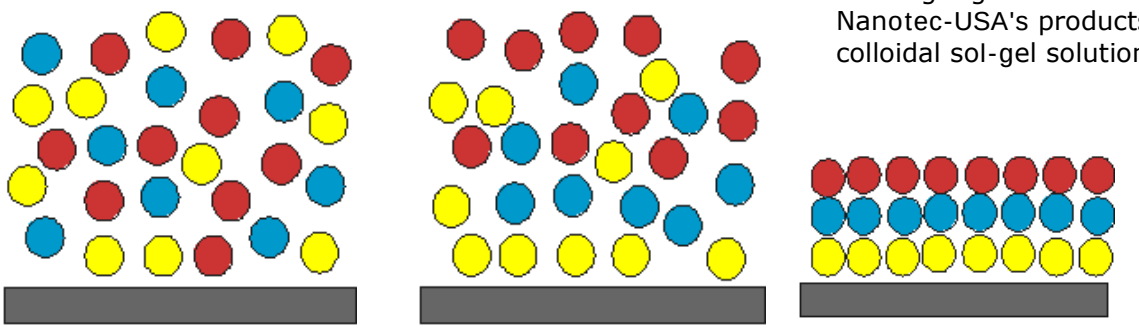
There are two general ways available to produce nanomaterial. The first way is to start with a bulk material and then break it into smaller pieces using mechanical, chemical or other form of energy (top-down). An opposite approach is to synthesize the material from atomic or molecular species via chemical reactions, allowing for the precursor particles to grow in size (bottom-up).

The sol-gel process, although known for more than one hundred years, has become one of the most attractive approaches for the formation of tailored thin films. It started as a method of making glass which does not involve a melting process.

Today's sol-gel processing is a form of nanostructure processing. It begins with a nanometer-sized unit and undergoes reactions on the nanometer scale, resulting in a material with nanometer features.

Sol-gel processing results in highly pure, uniform nanostructures.

Organic compounds such as alcoholates of silicon, sodium or calcium are used. With water, these compounds split into water and alcohol in a process of hydrolysis which also creates a structure where the metallic atoms are bonded to oxygen atoms in an irregular non-crystalline network, thus forming a gel. Nanotec-USA's products are colloidal sol-gel solutions.



Example: Red = repellent particles blue: Connecting particle yellow: surface bonding particle

**Figure 4: Self assembling illustration**

## WHAT DOES IT LOOK LIKE ON A SURFACE?

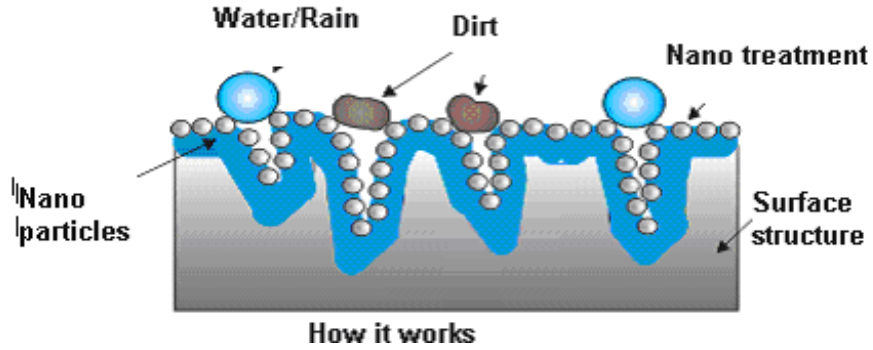



**Figure 5: Illustration of a Self assembling nano structure on a substrate. Hydrophobic surface effect appears.**

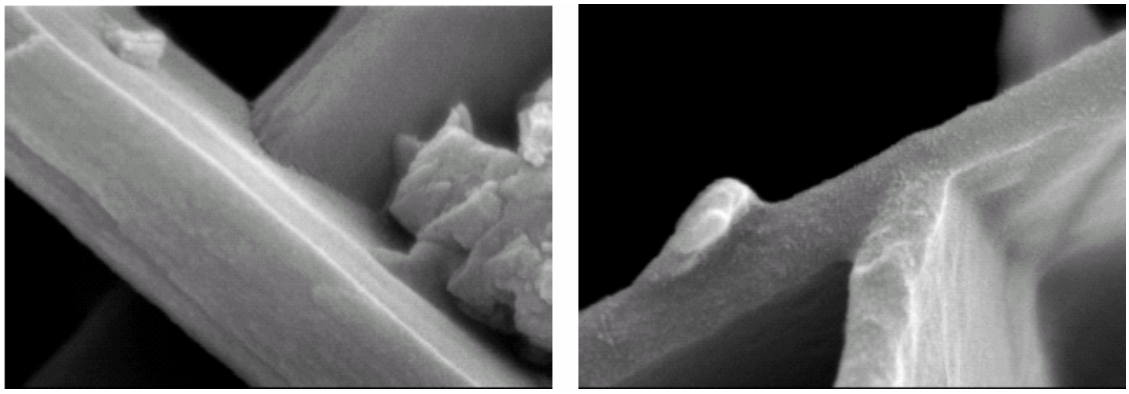
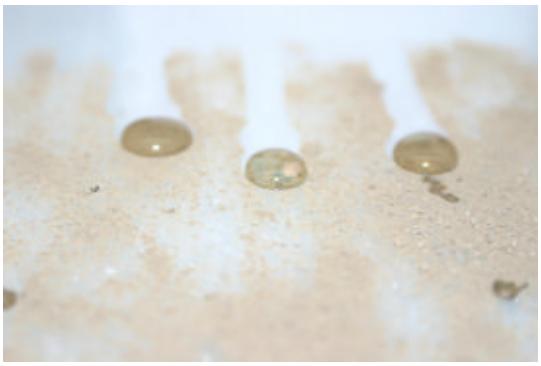


**Figure 6: Magnification 200,000 X**
**On the untreated surface all corners and edges are sharp and pointed. The treated stone crystals show rounded edges on the crystalline structure.**
**Treated surface shows more structured surface details.**

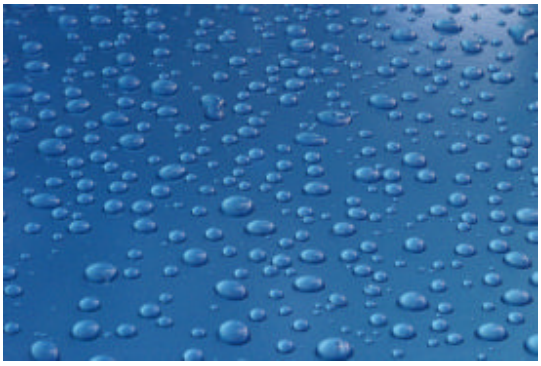
## RESULTS : LOTUS EFFECT ON A MAN MADE SURFACE.



Sample treated with a Nanotechnology Glass protection.

Dirt particles on the glass are getting picked up by water droplets. The high contact angle enables dirt particles to be more attracted to the water than to the surface (self cleaning effect).

The treated glass is less slippery than untreated glass samples.



Sample of treated car paint.

A treatment was applied to a painted car surface. Easy to clean properties and protection against staining contaminations. The car can be washed with de-mineralized water only and will look freshly detailed every time you do so.

(www.nanobioniccarusa.com )

Colored water droplets on wood treated with Nanotechnology water repellent for wood. Contact angles above 130 $^{o}$ can be achieved. Overall water absorption reduction ~ > 45 %. (Depending on the kind of wood species.)

## SUMMARY

Nanotechnology “products” can mean different things to different people. However, new technology should do things other products can’t do.

A key understanding of nanotechnology is that it offers not just better products, but also vastly improved manufacturing *and application processes*.

Nanoparticles and silicone atoms are not automatically Nanotechnology if they don’t have any function other than being small or having the same properties than their larger manifestation. (Our products are free of silicone, siloxane, PTFE and other polymer type materials)

The use of engineered Nanoparticles to create smart surface technology at the Nanoscale is definitely what Nanotec-USA understands under functional Nanotechnology.

As nanotechnology evolves from the laboratory into an industry, one of the greatest challenges still to be overcome is the explanation of nanotechnology products and the benefits to the user markets.

www.nanotec-usa.com
Nanotec-USA (866) 626-6187