

THE NEXT BIG THING (think small) - NANOTECH

You may not know it yet but Nanotechnology is about to shake up almost every business in the world. Nanotechnology is the science of building things atom by atom. It is molecular manufacturing. It's engineering at the molecular level. It's a technology that is giving us the tools to control the basic structure of matter. Everything that we know is made of it. Some say the possibility to create new things appears to be limitless.

Nanotechnology derives its name from a measurement called a nanometer. Nano comes from the Greek word for "dwarf" and means one-billionth of something. A nanometer is one-billionth of a meter. A nanometer is about four atoms wide (mighty small). A human hair is very small in diameter and is equal to about 75,000 nm.

Defining small further, nanotechnology is defined by some as the science and technology where matter between 4 and 400 individual atoms is modeled with precision measurement, manipulation and placement. Others define nanotech as things with one dimension no larger than 100 nm.

So why is all of this important? It's important because we will be involved with the rebuilding of simple structures at the atomic level, atom by atom. Most importantly, in nanoscale the classic laws of physics change, such that the physical properties of a material at the molecular range can be very different than at the macroscopic range that we are used to.

WHEN SMALL IS REALLY SMALL



THE EDGE OF A DIME
1 MILLIMETER

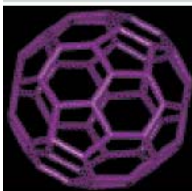
HUMAN EGG CELL
100 MICROMETERS



RED BLOOD CELL
10 MICROMETERS

CIRCUIT LINES ON CHIP
1 MICROMETER

VIRUS
100 NANOMETERS



BUCKYBALL
1 NANOMETER

HYDROGEN ATOM
0.1 NANOMETER

Data: Lux Capital Group,
BusinessWeek

Already scientists are manipulating atoms to create a myriad of new and astonishing molecules not seen before. Scientists are beginning to demonstrate better building block materials with exacting properties engineered to have radically new structural, electrical, chemical and optical properties. They'll likely be smaller, stronger and tougher, as well as lighter, more resilient, and less expensive. Because of the nature of the creation of these molecules, they are not natural occurring, therefore do not deplete resources that are unable to be renewed.

Nanotechnology will mostly be using the universes infinitely available raw materials (carbon, oxygen and hydrogen), engineering them at the molecular level atom by atom to create a universe of new products without depleting or disrupting the environment.

Nanotechnology is not only a technology of our future but the first applications have already appeared. For example the recording industry is using giant magneto recording heads and CD's rely on laser-based technology. Both of these utilize nanoscale technology. Fabrics have been made stain resistant by the use of tiny fibers. Some cosmetic and sunscreen formulators are using nanoscale technology to optimize ingredient utilization and eliminate caking. Some commercial processes for coating surfaces with nanolayers of various materials are years old in optical applications. Samsung is planning to have the first nanotube array TV's available by year-end.

Other companies are using nanotechnology to research and demonstrate:

- Transistors 100-times smaller and 1,000-times faster.
- Never flat automobile tires.
- Drill bits that almost never dull.
- Surfaces - windows, kitchens and bathrooms that never need cleaning.

- Eyeglasses that will never scratch.
- Antifreeze proteins that will prevent damage during low-temp transport of transplant human organs.
- A targeted heat therapy that kills only cancer cells.
- Safe, low cost anti-virus, anti-bacterial, anti-fungal microbe killing hand creams-lotions that kill even anthrax on contact.
- Diabetes reversing procedures involving nanoshells that will protect transplanted pancreatic cells from immune cell attack.
- Smart combat fatigues that detect toxins and biological agents and then excrete a defensive blocking agent. Chameleon like built-in color change will provide camouflage.
- Lithography free chip manufacturing allowing smaller circuit widths to yield more powerful, smaller chips.

More speculative possibilities include world changing nanotechnology applications as:

- A supercomputer, sugar cube sized capable of storing the entire U.S. Library of Congress.
- Smaller than human cell size bio-composites designed to make bones and tendons super strong.
- Engineered human molecules designed with the capability to “turn on and off” the protein messengers that control everything in our bodies.

Believe it or not we are rapidly moving into a real life science fiction world of endless possibilities for change. The world as we know it is about to be rebuilt atom by atom.

Naturally you want to know how nanotechnology will affect your graphic arts business. Well it’s already happening. For one, during last year an innovative new Ohio ink company introduced nanoparticle sized solvent-based and UV curable piezo ink jet inks. They offer super color saturation and shade cleanliness with the added benefit of running through print heads more clog-free. In another graphic arts application, polyamide flexible packaging films are being engineered using nanoparticle size clay powder additions. The structure demonstrates dramatic changes in properties offering improved clarity, increased tensile, impact and breaking strength, stiffness and modulus, softening

temperature, reduced shrinkage, etc., not to mention a great improvement in O₂ and CO₂ barrier properties. Look for these nano-composites in flexible and pouch packaging, and paperboard coatings.

More and more nano structured coatings will certainly be commercialized. The first and easiest to produce will be products like those mentioned above that utilize nanoparticle additives.

Already acrylic lacquers and epoxy resins have been modified with the addition of nanoparticles to yield clear coatings with improvements in scratch and wear resistance and

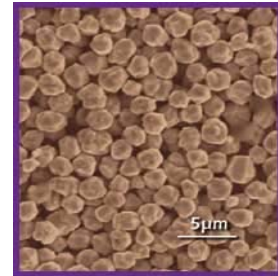


photo-stability-weatherability. In this case known sol-gel procedures were used to produce nanoparticle formulations with commercial silanes as raw materials.

Another technology, core-shell nanoscale polymer particle morphology applicable to liquid or powder coatings has been developed. Applications in coatings, paper manufacturing and adhesives have followed. Manipulating the shell functional groups allows the engineering of a particle that will for example, adhere to metal or if desirable offer greater clarity by replacing these functional groups with those that would provide gloss, or lower VOC’s. Additionally, water-soluble core-shell polymer particles have been shown that are biodegradable.

Summarizing, its fair to say that nanotechnology is receiving a lot of attention and we will all be exposed to new and better products in seemingly all areas of human endeavor.

Big and bigger surprises are certainly going to come from these very small packages!

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