The Alchemy of Nanotech

Ken Gilleo PhD
ET-Trends LLC

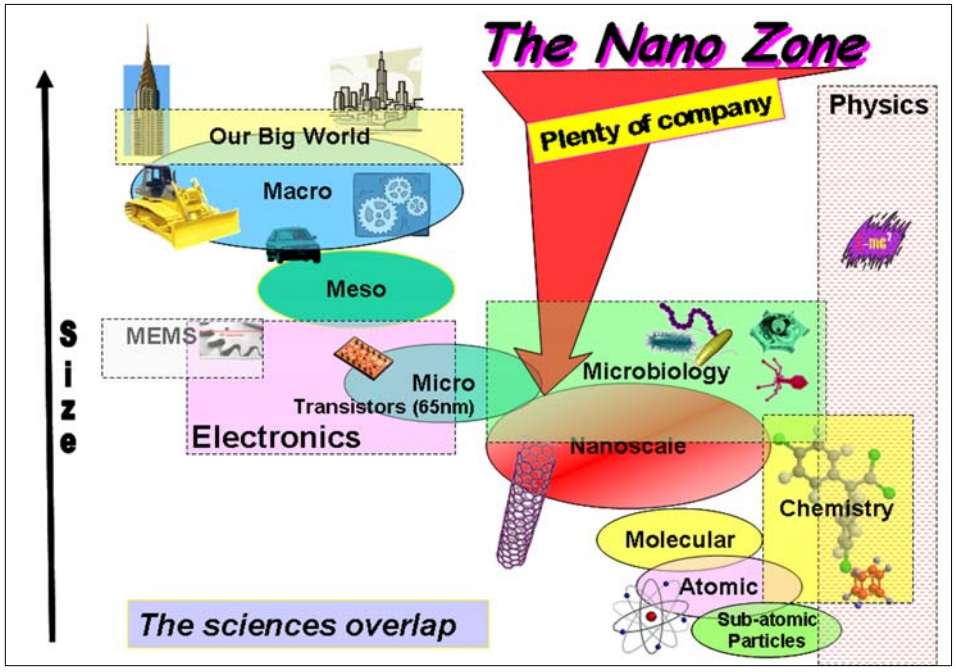
INTRODUCTION

"Nanotechnology" is the most overused term in the modern hi-tech lexicon. One reason is lack of a clear, precise, and well-bounded definition. Internet searching delivers 123,000,000 hits. Descriptions include everything from carbon soot to tiny machines that may never be built. Definitions range from, *"Nanotechnology is the ability to build machines on the molecular scale"* to *"Nanotechnology - the hip science of ultra-small"*. Some are even mutually exclusive. Maybe the marketing people know the best way to make money with Nano - a product name. It's no surprise that savvy Steve Jobs, grabbed the Nano term for the "impossibly small" iPod. And T.J. Rogers (Cypress Computer) is alleged to have said, "There are more con men and charlatans in the nanotech world than I've ever seen before". While waiting for clarification, let's explore the history of nanotechnology using the broad but imperfect definition, a size range of 1-100 nanometers (nm).

MORE THAN SCALE

First, let's look at relative scale around the NanoZone. Figure 1 shows regions where other ***sciences of the small*** fit. Note that biology, chemistry, and physics overlap the NanoZone. Chemistry also deals with objects (atoms and molecules) even smaller than nano; sub-nano.

Figure 1 (by author)



THE NANO HAS COMPANY - THE OLDER SCIENCES

Figure 1 clearly shows that Nanotechnology has plenty of company and doesn't "own" everything with nanoscale space. Many chemists view Nanotech as a subdivision of chemistry. Popular nano-molecules like *bucky balls* (C_{60}; ball-shaped with 60 carbon atoms) can be made by chemical reactions. In fact, chemist, Dr. Richard Smalley, was awarded the 1994 Nobel Prize for his work with these 3D chemical structures that he named *bucky balls*, or *fullerenes*, after geodesic architect, Buckminster Fuller. Biologists, especially virologists, also reside in the nanoscale world.

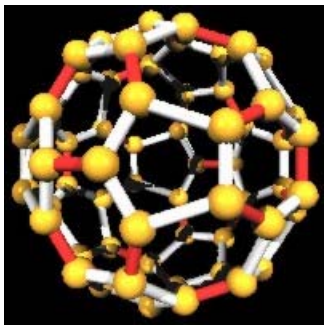


Figure 2 - Bucky Ball Structure (University of Texas)

HOW NEW?

Carbon black filler is the most widely-used nano-sized (8 nm - 300 nm) additive today. In 1926, tire makers began adding carbon to rubber to reduce wear. While Nanoscience, that didn't exist yet, would later study the particles, early developers knew that very small size was critical. IBM's discoveries and subsequent development of the atomic force microscope (AFM) most likely marked the beginning of Nanoscience a little over 20 years ago.

In 1921, there was another automotive nano-milestone when lead tetraethyl, an organometallic liquid, was added to gasoline as an octane booster. When ethyl gasoline burned in engines, nanoparticles of lead and lead oxide formed. Lead in most fuels was eventually banned in the 1980's after lead in humans reached dangerous levels. Although leaded gasoline certainly caused problems, ethyl aviation fuel (avgas) played a key role in WWII by enabling our fighters to fly faster and bombers to fly higher.

But can we take Nanotechnology back beyond the 20th century? Let's first explore nanoparticles since they're relatively easy to make and use. We hear a lot about nano-gold particles including use in medicine. Gold has a long history with important uses in art and medicine. The beautiful red cathedral window glass and red cups contained gold nanoparticle. The extremely fine nanoparticles produce a red color when dispersed in glass. Figure 3 shows an example of early red glass; the Lycurgus Cup.

Figure 3 - Red Lycurgus Cup

But gold nanoparticle can be suspended in water to make a colloidal gold, used for centuries as a medical treatment that reportedly *cleared the mind, increased intelligence and will power, and balanced the emotions*. Colloidal gold, with its deep purple color, is still valued as a health elixir and has long been available. But who was the first "nanotechnologist" to make gold nanoparticles? While this may take a little "faith", Moses may be the true *Father of Nanotech*. When Moses learned that the Israelites had made an idol to worship, the Golden Calf, all Hell broke loose. ***"And he [Moses] took the [golden] calf they had made and burned it in the fire; then he ground it to powder, scattered it on the water and made the Israelites drink it."*** [1]. Since the gold would not oxidize, the powder was gold metal.

Did Moses really make gold nanoparticles? It's hard to confirm. The gold/water was palatable, indicating very small particles and maybe Moses had divine help. Later [1493], alchemist Paracelsus prepared purple colloidal gold that he called *Aurum Potable*, and this assuredly contained gold nanoparticles based on the color. Michael Faraday deduced that these gold suspensions contained very, very tiny particles 150 years ago. But if you still aren't convinced of early nanotech, then consider gold leaf (30 - 125nm) that fits the definition for a nano-coating. It's been used for many millenia.

While there are dozens of other examples of early Nanotechnology, those presented were basic and may not satisfy a modern Nano-zealot. But what if you were offered a new, low-cost nano-conversion process? Metals would be magically changed to tough, durable dielectrics having an array of evenly-spaced nano-channels (20nm diameter) that could trap nanoparticles. These nanoparticles could be loaded into the long nano-channels that would "close and lock". The Nano-world would get excited. We could even trap nanoparticles that changed our material to any color. We might get government funding. But this nano-channel breakthrough is here – now (see Fig. 4)!

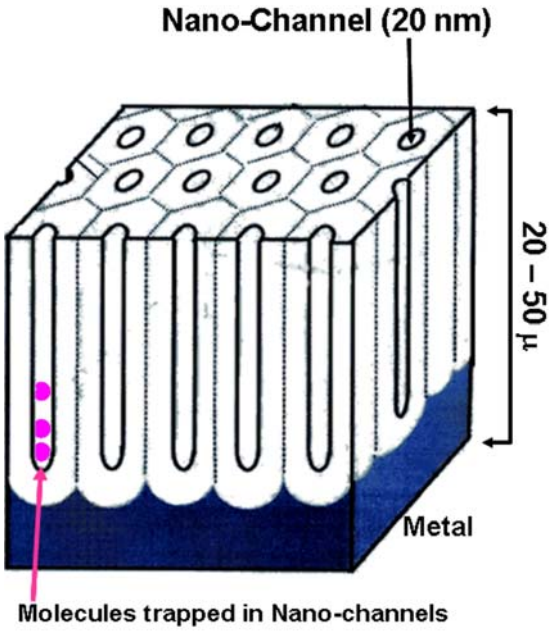


Figure 4 - Nano-channels

What is it? Color-anodized [trapped dye] aluminum invented in the 1920's. Let's hope that the government hasn't already given out the grant.

CONCLUSIONS

Nanoscience is new, but the technology is old. Though simple, but useful materials and processes were known to the ancients, future Nanotechnology holds great promise. Hopefully, the hype will be reduced, the charlatans will be kicked out, and honest results will be rewarded. The major payoffs will likely come in electronics and medicine - *and they will change the world*.

REFERENCES

1. Christian Bible, Exodus 32:20
2. M. Faraday. *Philos. Trans. R. Soc. London* 147, 145 (1857)