

The Alchemy of Nanotechnology

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There's been a steady stream of press releases on Nanotechnology announcing weekly breakthroughs from every corner of the globe. And, some of it may even be true! Unfortunately, there's so much hype that the "Nano" moniker now proclaims cool products. And the annoying clichés like "Big things from small technology..." wear Nano-thin. Yet, many of us believe that Nanotech will ultimately deliver significant results to fundamentally change the electronics and printed circuit board industries. Even today, materials based on nano-particles are commercially available and some, like nano-silica, are used as fillers. Nano-metals are now widely available and being considered for PCB and packaging applications. But are Nano materials new?

Chemists have been building sub-nano size molecules for over a century, and some have been bulking up their creations to move up to the larger nanoscale range with Bucky Balls (60 carbon atoms) and Carbon Nano Tubes (CNTs). So is there a chance that chemists and their predecessors, the Alchemists, were making "Nano-stuff", long before the big Nano-boom? Let's step back to seek out the Nanotech pioneers.

The fledgling automobile industry of the early 20th century had two Nanotech breakthroughs that provided a tremendous boost. In 1921, an organo-metallic liquid was found to greatly improve engine performance as a fuel additive. In fact, this material helped win WWII by enabling more powerful high-compression aircraft engines for faster fighters and higher flying bombers. Although the lead tetraethyl additive is no longer used for automobiles in most countries, it still goes into Avgas. Unfortunately, the compound produced toxic nanoparticles of lead and its compounds during combustion. And by the way, the Vaudeville magicians, who produce a bright flash and cloud of smoke with the wave of a hand, were using nano-lead powder. The ultra-fine powder, when flung into the air, instantly oxidized into a brilliant pyrophoric flash. Retired magicians didn't inhale.

But there was another Nanotech breakthrough in transportation that is still important today. Tire makers discovered (~1928) that carbon black (down to ~ 25 nm size), when added to rubber, doubled tire mileage. Researchers, although they couldn't measure individual particles, understood that very fine powder worked best and size-estimating methods of estimating were developed.

Looking further back, we find that Nano-metallurgy played a role in medicine and religion. Both gold and silver nano-particles were used in Biblical times and probably much earlier. The "red" color in many cathedral windows was produced by adding gold to molten glass to form a colloidal suspension of nanoparticles. The famous English scientist, Michael Faraday, deduced that the unexpected color was due to the extremely small size of the gold particles [1]. Even earlier, Alchemists were using Nano-gold and silver as colloidal suspensions in water. While there is no absolute proof of particle size, the fact that particles did not settle out of water, is strong evidence that this was

nanoscale technology. Colloidal gold (*Aurum Potable*) and silver elixirs (*Argentum Potable*) in water, advocated by ancient physicians, are still sold today.

Just how old is Nano-gold? The early metalworkers in Egypt and Mesopotamia, who invented the first lead-free solders [2, 3], probably made nano-gold. The Christian Bible provides convincing evidence and suggests that Moses may have been the father of Nanotech [4]. Moses destroyed the infamous Golden Calf with an intense fire, created powder, and made up a potable mixture of the gold in water. The Israelites were made to drink the liquid that was probably a colloidal suspension of nano-gold. While Moses was more concerned with spiritual health, this Bible reference may be partially responsible for the belief that imbibing gold is good for what ails you. One modern vendor calls it, "The Solution for the Soul". The Chinese also value gold for health and some exotic foods contain gold. While the value of imbibing Nano-gold can be debated, anyone wanting to test the idea can find a vendor by searching "colloidal gold" on the web. Maybe these veteran producers can change the product name to Nano and get government grants. But the long-established producers will find that the *Nouveau Nano* have copyrighted most of the cool Nano-names. Gold can also be beaten into gold leaf that is less than 100 nm thick (translucent) providing just one more example of ancient Nanotech.

Let's conclude by looking at *Natural Nano*. Creatures produce very strong, complex and exquisite nanostructures. The diatom, for example, now studied intensely by Nano-scientists, typically falls within the Nanoscale range. The real kick is that the diatom has been around for a billion years. So while Nano-science is very new, the technology is very old.

References

1. M. Faraday. *Philos. Trans. R. Soc. London* **147**, 145 (1857).
2. Gilleo, K., "First 7000 Years of Soldering - Part 1 - Metallurgy", *Circuits Assembly*, pp. 30-34, October 1994.
3. Gilleo, K., "First 7000 Years of Soldering - Part II- Polymers", *Circuits Assembly*, pp. 44 - 45, November 1994.
4. **Christian Bible**, Exodus 32:20.

[Photo, if there is space; diatom?, Golden Calf? ancient red glass cup or window?