Nano-Hoax?

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Ready or not, here comes Nanotechnology! But what is it - a threat, a promise, salvation, or a hoax? Is it something for Cookson? Right now, it's hard to find a clear definition among so much "hype & hope" surrounding the topic. Michael Crichton warns of the dangers of self-replicating "nanobots" in his fictional novel, "Prey". Forbes magazine warns of the "Nano Pretenders", companies in Nano-name only that might transform your funds into a nano-sized account. We'll be seeking answers to a big question about the tiny technology, the Nano-Paradox!

The US government is investing three-quarters of a billion dollars to boost the new field with its National Nanotechnology Incentive (NNI), so we had better take this seriously. Now, back to pinning down a Nanotech definition that seems to fly around like the "robo-bugs in "Prey". Nanotechnology is allegedly the production, examination, manipulation, transformation, and control of matter, energy, and information at the nanometer-scale (1-100 nm) using precise individual atom processes. The key is "atom-by-atom" assembly found in most definitions. Forget chemistry, it's too imprecise for the nano-gurus. Sure, chemists can "coax" atoms into molecules, but these bulk reactions follow the laws of science and not the wishes of man. Yet, there are over 10-million precise and unique chemical compounds on the known list and many are quite complex, so lets not discard the original Nanoscience just yet. Government reports talk about atom-by-atom construction, but much, if not most, of the sponsored work projects involve mass reactions, good old chemistry and mechanical processes. Cookson uses mass process to make everything from solder to solder masks, so if Nanotech is more than atom-by-atom assembly of molecules, we may want to join the Nanotech revolution. By the way, it's the US government that's calling it a revolution.

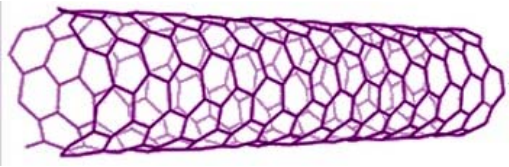
The Nanotech concept can be credited to the brilliant and delightful Nobel laureate Dr. Richard Feynman who looked 40 years ahead and predicted that products would be built one molecule or one atom at a time by the year 2000. His 1959 lecture, "There's Plenty of Room at The Bottom", gave birth to the nanotech concept. Feynman remarked, "What would happen if we could arrange the atoms one by one the way we want them…" Years later, K. Eric Drexler, independently arrived at the "atoms as building blocks" idea, eventually writing, "Engines of Creation" (1986), that proposed nano-assemblers for building desired nano-structures. Drexler wanted to rely heavily on modifying existing biological systems and then move to next-generation universal assemblers that could be programmed to "grow" anything, even more assemblers. Finally, in 1990, IBM was able to do atom-by-atom assembly using a modified atomic force microscope (AFM). Many feel that this was the true beginning of nanotechnology - the day that IBM wrote "IBM" by placing 35 argon atoms on nickel. So far, so good, so where is the paradox?

The problem is practical manufacturing, something that Cookson understands quite well. If one stays with the atom-by-atom definition, then any production rate would be seriously handicapped. There are an awful lot of atoms in a pound of product. And it took IBM all day to place the 35 argon atoms to spelled "IBM". Even if the atomic assembler could place a dozen atoms each second, the process would be orders of magnitude too slow. We need an assembly rate of many billions of atoms per second to ship products. Maybe we could just follow the Drexler plan, build a universal assembler, and let it clone itself? All we need to do is clone enough assemblers to keep up with the orders. What's so hard about this? Making the first assembler! The idea of a universal assembler can't easily be ruled out by science, but this "magic wand" philosophy should be compared to more established alternatives. One of nature's simple assemblers, the virus, is very complex, yet it can only make more viruses, not useful products. A universal assembler, or a vast team of "do-all-nano machines", would be much more complex, whether built from scratch or hijacked from nature. And who would do the programming for a billion parallel processing nanos? Are the sci-fi fans getting ideas?

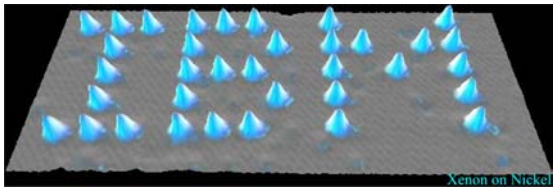
One hot field in Nanotech deals with Carbon Nano Tubes (CNT). They are 3-dimensional molecules made of carbon that look like hexagonal chicken wire formed into a cylinder, but only a few nanometers in diameter (1 nm = 1-billionth of a meter, or about 0.000000039 inches). IBM recently used a CNT to build a tiny transistor, and AT&T made a CNT triode amplifier. At least a dozen companies now sell CNTs and one offers a CNT synthesizer. The CNTs can be quite long, more than 5,000 times longer than their diameter. So it must take considerable time to construct them, right? Not really! They're manufactured using chemistry. Just add a carbon source like methane, introduce high energy, like plasma or a laser, and you can get carbon nanotubes, bucky balls (spherical molecules

made of carbon atoms), and other nano-species by the millions. Many "parts" falling under the Nanotech banner are products of chemistry. Bucky balls (fullerenes) have probably been around since prehistoric times and might be found in cave soot. Carbon is the "tinker toy atom" of Nanotechnology because it forms 4 bonds – the ideal building block for constructing 3D structures. Granted, the chemical reactions aren't so precisely controlled that you get a bottle of identical CNTs, but for now, this seems to be a good way to make Nano-stuff. The assumed randomness attributed to synthetic chemistry misses the point. The key is not forcing a single reaction to occur, it's separating, isolating, and purifying the mixture. Cookson is already involved with CNTs for thermal adhesives that could help solve overheating problems with new, powerful computer chips. Now back to the nano-paradox.

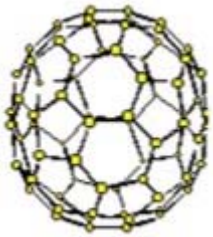
How do we make nano-materials one-atom-at-a-time and still get productivity? There are 14,000,000,000,000,000,000,000,000 carbon atoms in 1 ounce of CNTs. Maybe we just need a clearer and more comprehensive definition that includes use of traditional mass processes like chemistry, mechanical engineering and biology? Unless the government can clarify their Nanotechnology definition, they should beware of Nano Pretenders who might be modern-day alchemists turning government contracts into gold. In the meantime, Cookson will look deeper into Nanotechnology to find opportunities.



CNT Structure (each connection point is a carbon atom)



Written in argon atoms – IBM



Bucky Ball