Taking The Nanopulse -- Reducing Billions To Millions

Self-assembling nanomaterials will nano-ize manufacturing costs, too.

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Have you seen the latest nanotechnology news? IBM recently announced that they're building computer chips using a self-assembling nano-coating. I'll explain the amazing technology in a moment (and amazing it is), but here's the payoff that fascinates me. At the same time this new technology significantly increases the performance of the chip, the self-assembly nano-chemistry opens the door to reducing the cost of a chip fabrication facility by orders of magnitude -- from billions to a comparatively low-cost multi-million-dollar undertaking. More for less -- and isn't that what manufacturing is all about?

Let me explain how self-assembly changes the manufacturing process. Conventional chip-making uses lithography to place insulating walls between the miles of wire on a chip. This wall is needed to prevent the wires from siphoning energy from one another and interfering with operation. It's a difficult, time-consuming, multi-step process. Not to mention expensive. Think clean rooms, vapor deposition chambers and high-precision equipment. Moreover, as chips have become smaller and the components more tightly packed, the insulating walls have had to become smaller and smaller, making them fragile. That can reduce chip yield.

Now, here's how self-assembly changes the rules in the new IBM chip. Instead of building insulating walls between wires, the new process applies a material to the chip surface that, on its own, chemically self-assembles into a coating with trillions of uniform holes -- about 20 nanometers in diameter each -- across an entire 300 millimeter chip wafer. It's a pure chemical reaction -- no physical piercing, no masks, no "sandwich" of multiple coatings.

As IBM puts it, the process is the same as the way snowflakes and seashells form -- except the new method is exact, not random. Once the "hole-y" nano-coating is in place above the wires, a vacuum is created and sealed, creating insulating "airgaps" between the wires. The result? Nanotech self-assembly has helped eliminated multiple steps, simplified chip-making, and increase yield -- adding up to significantly lower-cost production. And you know what else? The company didn't have to build a new billion-dollar facility to achieve it. The first system is being integrated into an existing plant.

That's a billions-to-millions saving.

And remember the performance increase I mentioned earlier -- that's a nano self-assembly bonus. These airgaps on the chip are actually much more effective insulators than the conventional methods. The new technology allows electrical signals to either flow 35 percent faster, or to consume 15% less energy.

Of course, self-assembly isn't new. It's just that now we're beginning to fully understand how to harness it. In the early 1980s, while I was doing the university research that eventually launched my company, we developed a self-assembling film that could act as a both a transistor and a sensor. Today, self-assembly chemistry is prevalent in the work of companies in the nano-space.

In another approach to chip development, a company called Molecular Imprints uses self-assembling materials to create the template for chip lithography. The company NanoInk is using self-assembling materials to print identifiers onto pharmaceuticals. And Zyvex takes the technology to the next step with nano-manipulators that enable self-assembly of nano-components.

This is all good news for the chip industry, helping push the limits of Moore's Law again -- increasing performance while decreasing costs. But to me, the real story is that self-assembly opens up a version of Moore's Law to all types of manufacturing. I believe nanotechnology can drive manufacturing improvements by three orders of magnitude. 1/1000th the cost. 1000 times the performance. No, it's not going to happen tomorrow. Some of it won't even happen in this quarter-century. But remember this: IBM is already in production with plans in place for system-wide for expansion by 2009. Self-assembly is coming on fast. Do the math. What can nano-izing billion-dollar expenses to million-dollar expenses -- with higher performance products -- do for you?