Are nanobots on their way?

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[The first real steps towards building a microscopic device that can construct nano machines have been taken by US researchers. Writing in the peer-reviewed publication, *International Journal of Nanomanufacturing* from Inderscience Publishers, researchers describe an early prototype for a nanoassembler.

In his 1986 book, The Engines of Creation, K Eric Drexler set down the long-term aim of nanotechnology - to create an assembler, a microscopic device, a robot, that could construct yet smaller devices from individual atoms and molecules.

For the last two decades, those researchers who recognized the potential have taken diminutive steps towards such a nanoassembler. Those taking the top-down approach have seen the manipulative power of the atomic force microscope (AFM), a machine that can observe and handle single atoms, as one solution. Those taking the bottom-up approach are using chemistry to build molecular machinery.

However, neither the top-down nor the bottom-up approach is yet to fulfill Drexler's prophecy of functional nanobots that can construct other machines on a scale of just a few billionths of a meter.

Jason Gorman of the Intelligent Systems Division at the US government's National Institute of Standards and Technology (NIST) concedes that, "Nanoassembly is extremely challenging." Yet the rewards could be enormous with the ultimate potential of creating a technology that can construct almost any material from atoms and

molecules from super-strong but incredibly lightweight construction materials to a molecular computer or even nanobots that can make other nanobots to solve global problems, such as food, water, and energy shortages.

Gorman and his colleagues at NIST have taken a novel approach to building a nanoassembler and reveal details in a forthcoming issue of the International Journal of Nanomanufacturing. "Our demonstration is still a work in progress," says Gorman, "you might describe it as a 'proto-prototype' for a nanoassembler."

AFM is the most commonly employed approach for top-down nanomanipulation research, explains Gorman. However, AFM suffers from a number limitations, as the nanoparticles stick together during manipulation and cannot be lifted from the substrate. This means that nanodevices constructed using AFM may be aesthetically pleasing and provide insights into what might be achievable but it cannot build practical nano machines.

The NIST system consists of four Microelectromechanical Systems (MEMS) devices positioned around a centrally located port on a chip into which the starting materials can be placed Each nanomanipulator is composed of positioning mechanism with an attached nanoprobe. By simultaneously controlling the position of each of these nanoprobes, the team can use them to cooperatively assemble a complex structure on a very small scale. "If successful, this project will result in an on-chip nanomanufacturing system that would be the first of its kind," says Gorman.

"Our micro-scale nanoassembly system is designed for real-time imaging of the nanomanipulation procedures using a scanning electron microscope," explains Gorman, "and multiple nanoprobes can be used to grasp nanostructures in a cooperative manner to enable complex

assembly operations." Importantly, once the team has optimized their design they anticipate that nanoassembly systems could be made for around $400 per chip at present costs. This is thousands of times cheaper than macro-scale systems such as the AFM.

Gorman points out that it should be possible to have multiple nanoassemblers working simultaneously to manufacture next generation nanoelectronics. At the moment, his team is interested in developing the platform for scientists and engineers to make cutting edge discoveries in nanotechnology. "Very few effective tools exist for manipulation and assembly at the nano-scale, thereby limiting the growth of this critical field," he says.

"The work described in the IJNM paper is somewhat preliminary and focuses on the design and characterization of the micro-scale nanomanipulator sub-components," adds Gorman, "We are currently fabricating a somewhat revised micro-scale nanoassembly system that we believe will be capable of manipulating nanoparticles by the end of the summer," Gorman says, "We will publishing those results once they are available."

Source: Inderscience Publishers