

MOLECULAR MANUFACTURING

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What is Molecular Manufacturing?

If you're a Star Trek fan, you remember the replicator, a device that could produce anything from a space age guitar to a cup of Earl Grey tea. Your favorite character just programmed the replicator, and whatever he or she wanted appeared.

Researchers are working on developing a method called molecular manufacturing that may someday make the Star Trek replicator a reality. The gadget these folks envision is called a molecular fabricator; this device would use tiny manipulators to position atoms and molecules to build an object as complex as a desktop computer. As shown in this video, researchers believe that raw materials can be used to reproduce almost any inanimate object using this method.

By building an object atom by atom or molecule by molecule, molecular manufacturing, also called molecular nanotechnology, can produce new materials with improved performance over existing materials. For example, an airplane strut must be very strong, but also lightweight. A molecular fabricator could build the strut atom by atom out of carbon, making a lightweight material that is stronger than a diamond. Remember that a diamond is merely a lattice of carbon atoms held together by bonds between the atoms. By placing carbon atoms, one after the other, in the shape of the strut, such a fabricator could create a diamond-like material that is lightweight and stronger than any metal.

Researchers believe that molecular manufacturing also has the potential to revolutionize medicine. For example, sensors that are smaller than blood cells could be produced inexpensively. When released into a patient's blood stream in large numbers, these sensors could provide very accurate diagnoses. Nanorobots could be built using molecular manufacturing to perform surgical procedures in a more precise way. By working at the cellular level, such nanorobots could prevent much of the damage caused by the comparatively clumsy scalpel.

Molecular fabricators may be available to anybody, anywhere in about twenty years or so. When fabricators are available, any item whose design has been programmed into them can be produced cheaply and in large quantities. This could significantly improve living conditions in regions that do not have easy access to manufactured goods. For example, water filters could be produced to help in regions with contaminated water supplies and solar cells could make electricity available in the remotest jungle or desert.

However, molecular manufacturing could also turn our world's economies on their heads. Many manufacturing industries may be made obsolete and society could be transformed forever. Molecular manufacturing could spawn another industrial revolution that completely changes the way we do business. At the same

time, such advances could make it easy and cheap to produce powerful weapons. The ability to produce this kind of drastic change is the reason that nanotechnology is often referred to as a "disruptive" technology.

Who's Working on Molecular Manufacturing?

Though researchers are still at the stage where a lot of background work needs to be done, here are some organizations that are leading the way.

Organizations Providing the Infrastructure for Molecular Manufacturing

The Foresight Institute has developed a roadmap to guide researchers working toward molecular manufacturing.

The Nanofactory Collaboration's long term goal is to design, and ultimately to build, a working nanofactory. Their initial goal is the experimental demonstration of controlled diamond mechanosynthesis, i.e. using a mechanical tooltip to place individual carbon atoms in a structure.

The Center for Responsible Nanotechnology sees it as their mission to: "1) raise awareness of the benefits, the dangers, and the possibilities for responsible use of advanced nanotechnology; 2) expedite a thorough examination of the environmental, humanitarian, economic, military, political, social, medical, and ethical implications of molecular manufacturing; and 3) assist in the creation and implementation of wise, comprehensive, and balanced plans for responsible worldwide use of this transformative technology."

Nanorex develops 3-D modeling software that simulates nano-scale structures. Nanorex is planting the seed of MM in our schools by providing their modeling software free of charge to 'qualified' high schools and universities.

Organizations Working on Development of Molecular Fabricators

Zyvex was founded with purpose of becoming the leading supplier of tools and services to enable molecular manufacturing. They have developed nanomanipulators, MEMS design software and a process to functionalize carbon nanotubes. Zyvex is working on several projects, such as automated assembly of micro-scale components, that will add knowledge useful in working toward the long term goal of molecular manufacturing.

MIT's Center for Bits and Atoms may be the 500 pound technology gorilla in the MM jungle. One of this center's key goals is the development of molecular fabricators.