Researchers grow nanowire crystals for 3-D microchips

August 26 2009, BY CHRISTINE BLACKMAN

(PhysOrg.com) -- Stanford researchers have developed a method of stacking and purifying crystal layers that may pave the way for three-dimensional microchips.

The scientists added tiny germanium crystals in the shape of nanowires to a sheet of silicon, and then topped it with a layer of germanium. With heat, the nanowires and the germanium topping took on the crystal structure of the silicon. This process is a potential solution to the difficult task of layering germanium onto silicon, a step toward fabricating three-dimensional integrated circuits, or microchips.

"We can make very long and very small single crystals and, in principle, place them where they are needed on a surface," said Paul McIntyre, director of the Geballe Laboratory for Advanced Materials at Stanford and one of the four researchers on the project. "We use them as seeds to purify noncrystalline layers on top of the level of silicon and, therefore, control the perfection and orientation of those overlying layers."

To function well, microchips require crystals that have perfectly arranged atoms. Groups at Stanford and around the world are looking for ways to combine multiple crystal layers onto one chip. A multiple-layer chip is one approach to building a three-dimensional integrated circuit, which would contain densely packed conductors that produce more power per unit of surface area. Three-dimensional chips also benefit from shorter electron pathways that allow electrical current to flow more quickly.

The challenge is to build crystals that conduct electricity efficiently but are small enough to layer on a microchip. "Many scientific groups are trying to find something that will have more computing power, higher speed, lower energy consumption, and could continue to scale down for many years to come," McIntyre said.

To create a stack of crystal layers used on a microchip, "we have to find some clever way of depositing a layer that isn't a single crystal by purifying it so that it shares the perfect orientation of the silicon substrate," McIntyre said.

The group's unique approach starts with a layer of silicon crystal. Tiny crystal wires made of germanium are placed on the silicon and grow several millionths of a meter long. They're coated with silicon dioxide and a glassy layer of germanium. When heated, the crystalline structure from the underlying silicon is transferred to the germanium and its unordered atoms become perfectly arranged.

An unlimited number of layers can be purified to create crystals densely interconnected with nanowires. "Producing a potential electrical connection through the nanowire is quite unique. The ability to access each of these devices individually from layer to layer in an easy way is one thing that many people would like to have," McIntyre said.

The group, which also includes researchers Shu Hu, Paul Leu and Amy Marshall, published its results in *Nature Nanotechnology*.

More information: www.nature.com/nnano/

Provided by Stanford University (news : web)