

Cylinder head

Computers of the future may be made of carbon tubes

Nanotubes—tiny, hollow cylinders of carbon—have long been a product seeking an application. They are harder than diamond and dozens of times stronger than steel. Make them one way and they will conduct electricity like a metal. Make them another and they act as semiconductors, like the silicon used in transistors. Despite all this, their only employment at the moment is in quotidian things that need to be both light and stiff, such as surfboards and bicycle parts.

Visionaries still have hopes for them, though. One such is Max Shulaker of Stanford University. Dr Shulaker wants to make computers out of them. And, as he describes in a paper in this week's *Nature*, he has now done just that.

The first nanotube computer is a simple device, consisting of 178 transistors rather than the hundreds of millions found in a contemporary silicon chip. It can handle only one bit of data (ie, a "1" or a "0") at a time, whereas modern machines digest information in 32-bit or 64-bit chunks. And it can perform only one operation: subtracting one number from another and storing the answer in one of two places, depending on whether that answer is bigger or smaller than zero. But this is all a proper computer needs to be able to manage. Theoretically, Dr Shulaker's machine is capable of doing anything from working out your taxes to playing "Minecraft". It would just have to do them very, very slowly.

Building this machine meant overcoming two problems. One was getting the tubes that formed the transistors to point in the right directions. As their "nano" sobriquet suggests, their dimensions are measured in billionths of a metre, which makes them hard to handle. The other was making sure all the tubes used were of the semiconducting rather than the metallic variety, so that they could indeed be turned into transistors. (It has proved tricky to produce batches of tubes consisting exclusively of either sort.)

To align their tubes, Dr Shulaker and his team grew them on strips of quartz, the crystal structure of which left 99.5% of them pointing in the right direction. The remaining 0.5% were dealt with by designing them out of the circuit when the array of tubes was pruned to create the network of transistors that constitutes a computer.

To destroy the metallic tubes the team first used an electric field to turn the semiconducting ones into insulators. They then shot a powerful pulse of electricity through the whole lot. Only metallic nanotubes could conduct this pulse. Therefore only they were burned away by the strength of the current.

The point of all this is that silicon seems to be coming to the end of its life as the material of choice for making computer processors. As transistors get smaller, they leak more current—but nanotube transistors leak less than silicon ones. Using them could cut power consumption by 90%. Dr Shulaker, moreover, has tried to make his manufacturing process compatible with the way silicon-based electronics are created, so that the two can be integrated easily. Whether it will work remains to be seen. But if it does, carbon nanotubes, long a Cinderella material, will at last get to go to the ball.

Fonte: The Economist, London, v. 408, n. 8855, p. 76, 28 Set. a 4 Oct. 2013.