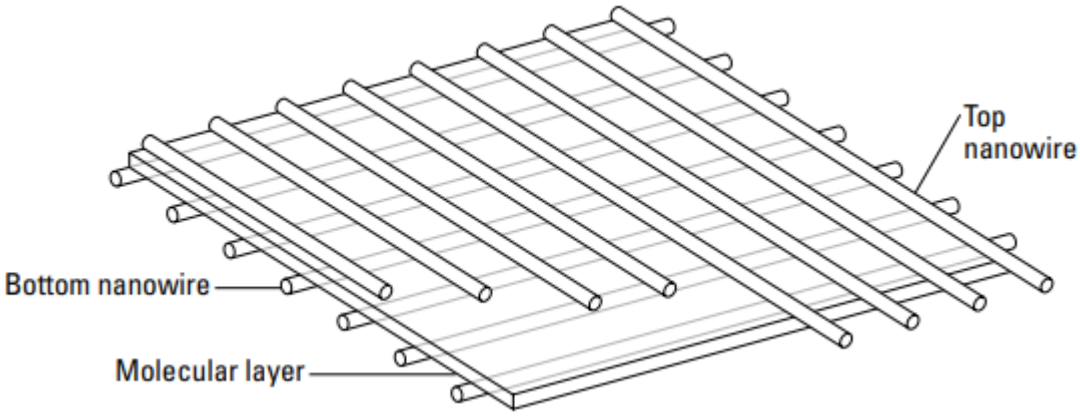
Lecture-10. Nanowires

Several research groups have demonstrated the use of nanowires to create memory devices and transistors. Researchers at Hewlett-Packard and the University of California at Los Angeles have demonstrated that a memory cell can be formed at the intersection of two nanowires. You can see a crossbar array of these nanowires in Figure 4-7 (courtesy of Hewlett-Packard). Using a somewhat more complicated array of nanowires, they have also come up with a transistor-like device called a crossbar latch.



Folks at the University of Southern California and the NASA Ames Research Center have demonstrated a memory device that uses indium oxide nanowires. They are predicting that this device will be able to store 40 gigabits per square centimeter, which is a lot of data by anybody's standards. Building transistors and memory devices used in computer chips from materials about the width of a nanometer, such as nanowires, is called molecular electronics. We discuss molecular electronics in more detail in Chapter 8. Meanwhile, over at Harvard University they've demonstrated a nanowirebased sensor that can detect diseases in blood samples. The working part of the sensor is a nanowire that has been functionalized by attaching certain nucleic acid molecules to it. The nucleic acid molecules bond to a cystic fibrosis gene if it is present in a blood sample. When this happens, the conductance of the nanowires changes. The change in the nanowire conductance causes a current to flow. This type of sensor has the potential to provide immediate analysis of blood samples for a variety of diseases, possibly right in your doctor's office with just a pinprick in your finger. That's much more convenient than giving vials full of blood and waiting for a test to come back from a lab. Add to that, this sensor is highly sensitive and might detect diseases we've never even been able to detect before, or detect viruses at an earlier stage. But there's a major challenge for researchers developing this technique, either with nanowires or nanotubes: They have to find a way to make the sensors selective and prevent false signals. In the Harvard demonstration, they did this by using a specific nucleic acid that would only bond to the cystic fibrosis

gene. We talk more about nanotechnology in medical diagnosis in Chapter 10. Finally, researchers at the National Institute of Standards and Technology, as well as the folks at the Max Planck Institute, are investigating the use of nanowires to increase the density of a magnetic recording medium (such as the disk drives used in computers). Both groups have been able to deposit arrays of magnetic nanowires — and their work shows that it's feasible to use this type of structure to store information at a much higher density than current disk drives can. However, other researchers are investigating the idea of using certain arrangements of nanoparticles to do the same thing as nanowires. It's a toss-up as to which idea will win out.