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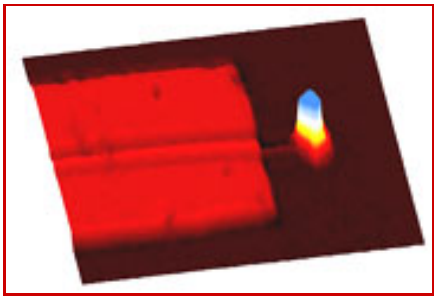
Lasers slim enough for chips

Optical fibres thousand times narrower than human hair produce laser light.

16 January 2003

PHILIP BALL



Blue-green light beams from the ends of the nanowire
© Charles Lieber

US scientists have made tiny lasers that can be incorporated into silicon microchips. The devices could help make information technology faster and more compact.

Built by Charles Lieber and coworkers at Harvard University in Cambridge, Massachusetts, the lasers are single wires of the semiconductor cadmium sulphide. Called nanowires, they measure just a hundred millionths of a millimetre across[1].

Optical fibre lasers are now standard in telecommunications and medicine. Shrinking them about a thousandfold may open up new applications. Nanowire lasers might, for example, give laser surgery unprecedented precision. Or the tiny light sources could probe the contents of living cells, or carve out delicate microelectronic circuitry.

Lasers are also central to information transmission: pulses send signals from electronic circuits down optical fibres. Currently lasers are too big to fit on a silicon chip and so the interface between the electronics and the optics is cumbersome and delicate. Semiconductor nanowire lasers might ease this problem by sitting comfortably on a chip.

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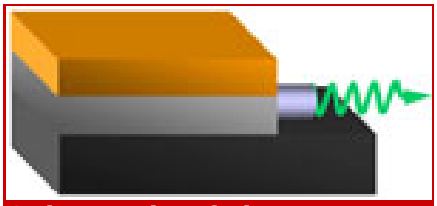
Several groups, including Lieber's, can make nanowires of a specific composition and size. Recently these have been used to make a variety of electronic devices.2,3

In fact, the first nanowire lasers were made in 2001, from zinc oxide; these emitted light in the ultraviolet range.4 But they could only be switched on by being pumped with light from another laser. For most applications lasers must be capable of being switched on and off electronically.



Schematic of the new device
© Charles Lieber

Lieber and his colleagues have achieved this crucial electronic control. They make a cadmium sulphide nanowire atop a silicon surface, and then lay down an electrical contact on top of that. At a certain voltage, a current passes from the silicon into the nanowire, and blue-green light beams from the ends of the wire.

When the injected current is big enough, the light is almost entirely of a single colour - it has a very narrow range of wavelengths. This is a telltale sign of laser light. Sources such as incandescent bulbs and diodes produce a broad spread of wavelengths.

The light colour depends on which semiconductor a wire is made from. Gallium nitride produces blue-to-ultraviolet light, indium phosphide generates infrared radiation. Lieber's group has made nanowires from all these materials and so hopes to span the visible spectrum with nanowire lasers.

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