From slivers of material that confine electrons in fewer than three dimensions may arise the next generation of electronic and optical technologies.

TINY SURFACE-EMITTING LASERS, measuring six microns high and one micron in diameter at the base, are each composed of more than 30 aluminum arsenide and gallium arsenide mirror pairs. Light is emitted and amplified by a quantum well located in the middle of the stack. The mirrors trap light and cause multiple reflections to occur within the stack.

The lasers are made by carving through a layered semiconductor wafer using a chemically assisted ion-beam etching technique. Before the devices shown could be tested, the structures had to undergo more processing, including the addition of thin metal contacts on top of each laser. Such microlasers, made at Bell Communications Research, can emit several milliwatts of infrared light through the transparent substrate at their base.

It's late on a Friday evening in Red Bank, N.J., and most of the corridors in Bell Communications Research (Bellcore) have fallen quiet. In one small laboratory, a lone young woman studies a set of graphs glowing fluorescent green on her computer screen. Behind her, a blue-green ribbon of light from an argon laser zigzags through a gauntlet of lenses on a table, then disappears through a porthole into a stainless steel cylinder fed by a supply of liquid helium from a steaming, ice-coated pipe. There, inside a chamber cooled below five kelvins, the beam runs squarely into its destination: a microscopic speck centered in a flat, black square that measures barely a few millimeters itself. Excited by the blue-green laser, the speck spits out its response—a brilliant mote of red.

This play of light intensely interests Maria Brasil, even if she has her back to it. How much light does the speck emit? At what wavelength? The answers lie in the slow accumulation of data plotted on Brasil's computer screen. What she sees there will cheer her colleagues. The speck emits light at the precise frequency predicted by its builders.

Bellcore's tiny red-light emitter, smaller than a grain of sand, is a harbinger of a new age of electronic and optical materials, namely, that of "quantum" devices. Over the past few years the technology for manipulating and observing matter on an atomic scale has advanced at an astonishing pace. This past April researchers at the IBM Almaden Research Center in San Jose, Calif., even spelled out their company's name with xenon atoms by using a scanning tunneling microscope.

Although moving individual atoms is still a laboratory game, laying down exquisitely thin films of atoms has become serious business. By controlling precisely the structure and composition of layers of materials only an atom or two thick, scientists are proving they can program the electronic characteristics they want into a compound. "It's like having your hands on the knobs of nature," says Mark A. Reed, a professor of electrical engineering at Yale University.

The red speck at Bellcore, for example, is a complex tower made of slices of zinc selenide and zinc telluride semiconductors. Each layer is no more than 20 angstroms thick—several hun-