RLE currents

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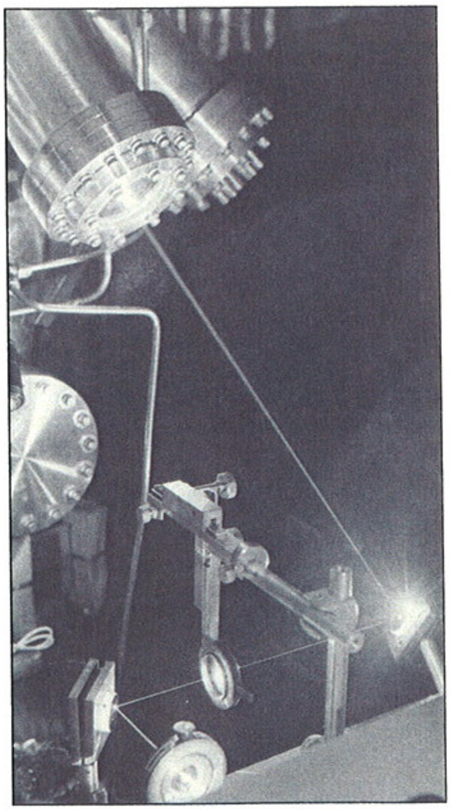
The Research Laboratory of Electronics at the Massachusetts Institute of Technology

PATHWAYS TO THE FUTURE AT RLE

Forty-five years ago, the Research Laboratory of Electronics emerged from MIT's wartime Radiation Laboratory with an emphasis on radar and physical electronics. Today, the laboratory continues to study all aspects of electronics and optics, but its concern with information processing has led to a large activity in language, speech, and hearing as well. In addition, RLE research groups focus on atomic and molecular physics, radio astronomy, plasma physics, signal processing, electromagnetics, and communications. Research in RLE is highly interdisciplinary, bringing together investigators with many diverse backgrounds. In order to both understand a broad array of phenomena, as well as construct complex systems, studies dwell at the extremes of size (smallest and largest), time, and frequency. Many other themes will also emerge from a broad sampling of RLE research, providing a sense of the vigor and excitement within the laboratory.

Perhaps the most overwhelming characteristic and driving force of much of RLE's research is the rapid growth of new technology. Techniques for making structures only a few hundred angstroms in size have revealed new physics and device opportunities, and fine-tipped electrodes are used routinely to probe the neural basis of behavior. Lasers are used almost everywhere, and complex machines for epitaxial growth allow control at the single monolayer level. Computation plays a central role in much of the lab's research, and small-scale toroidal magnetic confinement systems probe the fundamental properties of plasmas while large-scale cyclotrons provide the focused energy to study surface behavior in electronic materials. Indeed, the continuing discoveries afforded by these technological means are exploited to build the next generation of technology, opening up new areas of study and invention.



During the metalorganic molecular beam epitaxial growth process, a low-power laser beam illuminates the front surface of a thin film in order to enhance its growth rate. Enhanced growth has important implications for selective area epitaxy and in situ *tuning of surface stoichiometry, the numerical relationship of elements and compounds as reactants and products in chemical reactions. (Photo by John F. Cook)*

As the name of the laboratory suggests, electronics has been a continuously evolving research focus, where much of the emphasis is on making ultrasmall structures and devices. In the vertical dimension of growth, single monolayer control allows for a wide variety of quantum wells utilized through "bandgap engineering" to form new devices. In the planar dimensions, however, while lithographic control extends well below 1,000 angstroms, there is new interest in chemical forms of self-organization to provide structures at a degree of resolution that cannot be achieved by any direct, external control method. A whole new area of study, called "mesoscopic physics," explores phenomena in devices which are smaller than a tenth of a micron, but not as small as individual atoms. At this level, new theories of transport are being developed, and the recent discovery of a "single-electron

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