book is based on a course run at the University of Leicester, and the methods are selective but well described, as one would expect from its provenance. Little effort, however, has been made to make the contents of more general use. There is no index and some methods occur in unexpected places; for example the transformation of *E. coli* is found in the section on cDNA cloning. It is always useful to see how experiments are performed in other laboratories, but those buying *Gene Cloning and Analysis* should be aware that it contains a limited range of techniques.

The last book, Vol. III of Glover's *DNA Cloning,* is a recent addition to the successful *Practical Approach* series published by IRL Press (Vols I and II were reviewed in *Nature* **317,** 679; 1985). Ten topics are covered in the new volume, each of them by an expert in the area. There are two chapters on the uses of cosmids and three on different aspects of eukaryotic polypeptides expressed in *E. coli.* The subjects of other contributions include the use of yeast and mammalian cells as hosts for the expression of foreign genes, retroviral vectors and transgenic mice, and there is also a timely and up-to-date chapter on the generation and use of RNA probes. The difference between this book and the others reviewed here is that it addresses very specific and occasionally esoteric topics, and does not claim to be a comprehensive laboratory manual. Nonetheless, the book and its predecessors make very useful companions in the laboratory.

It is clear that the manual needs of the molecular biologist are now as well catered for as those of DIY enthusiasts. Such manuals should never replace the drive inherent in a scientist to do things quicker and better; an unquestioning dependence on the protocols of others can stunt one's intellectual growth. For all that, some of these books are now welcome fixtures in our laboratory, and their appearance has stopped forever a project to publish our own manual of gene cloning techniques. □

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• Molecular biology manuals continue to appear — recently published by Martinus Nijhoff is *Plant Molecular Biology* edited by Stanton B. Gelvin and Robert A. Schilperoort, a loose-leaf manual to which further sections can be added as they are published. Price is Dfl.110, \$52.50, £32.50. Also, the second edition of *A Practical Guide to Molecular Cloning* by B. Perbal is to be issued by Wiley in June, with updated descriptions of sequencing, *in vitro* expression of cloned genes, and use of computers for the study of nucleic acids. Price is hbk £90, \$99.50; pbk £42.50, \$49.50. For review see *Nature* **316**, 222 (1985).

Material change

John R. Barker

GaAs Devices and Circuits. By Michael Shur. *Plenum: 1987. Pp.670. \$90, £50.*

THERE has long been a popular belief that gallium arsenide (GaAs) will eventually replace silicon as the basic material for advanced integrated-circuit technology. The argument is usually based on the *assumption* that industry needs ever-faster electronic devices and the *fact* that gallium arsenide is intrinsically a much faster material than silicon. By 'faster' it is meant that the electrons in gallium arsenide may be accelerated more rapidly and achieve higher limiting speeds than in silicon. The speed difference is set by fundamental material properties such as the energy-band structure and the details of electron–phonon scattering. There are signs now of rapid growth in commercial GaAs integrated-circuit technology, but the ultimate competition with silicon is not one just of speed.

Silicon has achieved its present supremacy by a scaleable technology which can accurately produce digital logic and memories which are not only fast but which have high-integration densities. The key is the existence of a well-matched insulator, silicon dioxide, which provides the basis for the highly controllable metal-oxide-semiconductor field-effect transistor (MOSFET) technology. Unfortunately there is no comparable insulator for gallium arsenide, and the fundamental device technology is therefore quite different. With gallium arsenide, the basic field-effect transistor action is achieved by using the potential barrier at a metal–semiconductor interface to control the size of the conducting region in the device channel; this is the basis of metal-semiconductor field-effect transistor (MESFET) technology. At first sight this alternative technology should not be a problem, and record-breaking oscillators were being produced by 1.0 μm gate GaAs MESFETs as long ago as 1970.

On the other hand, for MESFET-based *digital* logic or memories it is vital to have extremely accurate control of both the layer thicknesses and the doping distribution within the conducting layers. Compared to silicon, the subsequent materials technology is hampered by the lower solubility of impurities. The lower chemical stability of gallium arsenide puts a much greater restriction on the range of processing techniques and temperatures that can be used. The roots of the problem may thus be partly traced to the long learning curve in the underlying materials science of gallium arsenide and the restrictions that has placed on the device structures. However, the past two years have seen commercial production of GaAs integrated circuits, including gate arrays, and the announcement of ambitious programmes on GaAs RISC microprocessors and GaAs-based supercomputers.

The pace of silicon miniaturization means that ultimately the challenge to digital circuits from gallium arsenide has to take place at sub-micrometre geometries where silicon technology is already within sight of its basic limit. This is about 0.2 μm minimum feature size, which should be achievable commercially within the next decade. The physical laws which govern the operation of traditional MOSFET devices permit a further reduction to 0.1 μm if liquid-nitrogen temperatures are used, a feature which is already being deployed in recent supercomputer products where a lower temperature improves the silicon mobility. This is a fascinating development, because low-temperature operation strongly favours gallium arsenide for which a wide range of high-performance device structures exist, and for which devices have already been demonstrated on space scales below 0.1 μm.

Michael Shur's useful and timely book is the first thorough introduction to the understanding of classical GaAs devices and circuits, with an emphasis on very small devices. The material should also provide an excellent background for researchers working on the exciting new range of quantum devices fabricated with gallium arsenide. The strength of Shur's approach comes from his involvement in the large US programme on sub-micrometre electronics, which has explored the fundamental limits of conventional device structures as well as building a rich variety of novel devices. A wealth of references will ensure that this remains a valuable source book for many years. The breakdown of conventional device models at small dimensions is significant at larger scales in gallium arsenide than in silicon, and this area is particularly well discussed, especially classical ballistic electron transport.

As well as describing the wide-ranging GaAs logic families which are of immediate commercial interest, Shur has produced a good introduction to the theory and modelling of modulation doped field-effect transistors and other devices such as the heterojunction bipolar transistor which are based on GaAs–$(GaAs)_x(AlAs)_{1-x}$ layered heterostructures. The potential strength of gallium arsenide is made very clear in these areas, where the flexibility for materials design and innovation far exceeds the present capabilities of silicon. □

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