editorial

Microscience and basic research

The articles in this special issue on microscience call attention to a new and fast developing interdisciplinary science underlying a worldwide growth industry of extraordinary technical vitality. Currently microelectronics technology sustains over 50 billion dollars of industrial activity. The cost of manufacturing silicon electronic devices and circuits has declined dramatically as microfabrication permits their size to be shrunk and their numbers increased on a single silicon wafer. But the uses of integrated circuits have expanded even more rapidly than the costs have come down, providing rapid growth for the industry and powerful incentive for still greater technological progress.

Although we usually think of basic science leading technology, microelectronics is an example of a field in which the technology has led the science. But this can not continue to be the case. Further expansion in this new and exciting field will be tied more and more to progress in basic research at universities and other centers as well as at industry laboratories. In the process of building structures whose critical dimensions approach a wavelength of visible light, the designers of industrial processes are in serious danger of outrunning their scientific interference, so to speak. The tools and processes that seem to be attractive for future progress involve phenomena that in some cases are poorly understood and in others even thought to be the province of branches of basic science with no apparent industrial application.

For example, reactive ion etching combines the complexities of plasma chemistry and surface science. Ion implantation and molecular-beam epitaxy invoke much of atomic and molecular physics. Even a tool of the high-energy physicist—the radiation from electron storage rings—has become a powerful tool for surface analysis and may yet prove to be a useful lithographic source. Even cosmic-ray physics finds its place—albeit an unwelcome one—in very large scale integration (VLSI) of computer memory cells, for both cosmic-ray showers and trace contaminants of radioactive materials can cause "soft" failure, changing the data stored in the computer's memory.

Industry has already recognized the need for basic research to support further growth in this field and is providing opportunities for collaboration between peer scientists at university and industrial laboratories. But given the economic interest in industrial competitiveness and the national security interest in military and space applications microelectronics, the US government is also increasingly interested in stimulating expanded participation by universities in this field. Support programs have been launched by the NSF (see pages 32 and 34) and the defense agencies. This is a most welcome turn of events from the industry point of view. But how can universities participate most effectively in work so closely tied to industrial facilities and economic considerations? Some universities will engage in VLSI device design and engineering. But most will make the most useful contributions by pursuing scientific questions of fundamental interest for which the tools and techniques of microfabrication are prerequisite.

Programs aimed at supporting research by universities related to VLSI technology should then encourage scientists of all disciplines to acquire the skills and equipment for microfabrication—and go on to invent and develop new tools—to be applied to the scientific questions of greatest interest, regardless of their relevance to the microelectronic industry's current problems. This approach will not only benefit the various basic sciences involved, such as biology, physics and chemistry, but will also enhance the likelihood of innovations that could result in further dramatic stimulation of industry in this new field.

LEWIS BRANSCOMB
Chief Scientist
IBM Corporation