

**BUSINESS DAY**

# I.B.M. to Make Smaller and Faster Chips

By LAURENCE ZUCKERMAN SEPT. 22, 1997

I.B.M. plans to announce today that it has solved a fundamental problem holding back the development of faster semiconductor chips and will begin manufacturing chips early next year that are smaller and up to 40 percent more powerful than the most advanced chips currently being produced commercially.

The announcement is the second semiconductor breakthrough in less than a week, and it underscores that Moore's law, an industry maxim that holds that the performance of chips doubles every 18 months, must now be rewritten as improvements in chip technology come ever more rapidly.

Last week, the Intel Corporation -- whose co-founder Gordon Moore formulated the law in 1965 that came to bear his name -- said it had developed a way to double the storage capacity of so-called flash memory chips, which are used as storage devices in personal computers, video games and cellular phones.

The announcement expected from the International Business Machines Corporation is perhaps more significant because it advances the process used to make all types of semiconductors, including microprocessors, memory chips and special-purpose chips employed in everything from automobiles to high-speed networks.

"It is a major breakthrough that everyone has been trying to make, and they have pulled it off," said Bryan Lewis, principal semiconductor analyst at the market-research firm Dataquest in San Jose, Calif. "It is even more significant than the Intel announcement because it has implications across the whole semiconductor industry."

An added benefit is that I.B.M. said its new manufacturing process is 20 to 30 percent less expensive than its current method. That means that chips will not only get more powerful but that they are likely to fall dramatically in price.

The technological breakthrough that I.B.M. says it has made concerns the metal that is combined with silicon to produce semiconductors. For the last 30 years, chip makers etched circuits onto aluminum that was placed on top of the silicon. Most chips sold today contain transistors that are 0.35 micron wide. The most advanced have circuits with a width of 0.25 micron. But at 0.20 micron, or about a five-hundredth the width of a human hair, aluminum begins to slow the chips down.

"As you get down to these very small dimensions the aluminum can't conduct enough electricity to make these circuits move fast enough," said John Kelly, vice president for technology of I.B.M.'s microelectronics division.

Copper is a much better conductor. But when chip makers tried to use it, they found that the metal bled into the silicon, contaminating the chip. Researchers at I.B.M. and other companies tried gold and other expensive materials, but they didn't work.

"We went down many many blind alleys," Mr. Kelly said.

Finally, after 10 years of work, researchers at I.B.M.'s laboratory in Yorktown Heights, N.Y., figured out a way to insulate the microscopic copper wiring so that it does not come directly into contact with the silicon.

I.B.M. is not the only company to find a solution. Last month, Sematech, the 10-year-old research consortium financed by 10 American chip manufacturers, including I.B.M., announced that it had produced silicon wafers -- the basic building block of a chip -- with copper deposited on them.

But I.B.M. is much further along. The company is already producing finished chips on a small pilot manufacturing line in Fishkill, N.Y. And it is in the process of moving the line to its main semiconductor fabrication plant in Burlington, Vt. It intends to begin offering the chips commercially in the first half of next year.

"For the next year or two, they clearly have a lead," Mr. Lewis of Dataquest said. "They are going to gain market share in the semiconductor world."

Intel, which has also been trying to develop copper chips, does not plan to begin selling them until 2002, Howard High, a spokesman, said. "If they can move it into production this early," he said, referring to I.B.M., "that is certainly more aggressive than we and others had anticipated."

The first of I.B.M.'s new copper chips will appear in its high-end computers. In addition to mainframe computer chips, the new process will also be used to make PowerPC chips, which are used in I.B.M.'s RS/6000 and AS/400 computer lines as well as the Apple Macintosh. These new chips will run at speeds as fast as one gigahertz, compared to the fastest microprocessors found in today's personal computers, which run at 300 megahertz.

Mr. Kelly said that I.B.M. had applied for several patents related to the new process and did not plan to license the technology to other companies.

But I.B.M. does help other companies design and manufacture custom chips. Mr. Kelly said that the new process would first be used to make chips that demand high performance, such as fast memory chips and so-called application-specific chips used, among other things, to power the switches that route data on the Internet.

Chips with more densely packed circuits also require less energy so the new process could be used to make semiconductors for battery-powered pocket cellular phones and other hand-held gadgets.

"Eventually, all semiconductors will go to copper because as you get down to those dimensions you have no choice," Mr. Kelly said. "Had we not figured out how to do this, Moore's law would have slowed down dramatically."