Supplies of new chip metal hafnium remain untested

Tue Feb 13, 2007 7:46PM EST

By Carole Vaporean

NEW YORK (Reuters) - Hafnium was unknown to nearly everyone but a handful of scientists and engineers until late January, when Intel Corp. and IBM announced their faster, more efficient microprocessors would be constructed using the silvery metal.

Yet the stable and benign element listed at No. 72 on the periodic chart accounts for the breakthrough to the next generation of semiconductor. Chipmakers eventually plan to install it in everything from servers to cellphones.

Once the rare element becomes so pervasive, however, is there danger of supply shortages?

The question drew laughter from those in the know. Not from ridicule, but because the minuscule amounts used in even billions of transistors boggles the imagination.

"Even if you took all the hafnium on a 12-inch (chip) wafer you'd be hard pressed to see it with the human eye," said Jim McGregor, analyst at technology research organization In-Stat.

Hafnium oxide will replace the layer of silicon oxide in tiny transistors or microprocessors that go into a chip. One chip requires hundreds of millions or even billions of them.

IBM Chief Technologist Bernard Meyerson put the supply situation in greater perspective: the hafnium in a cubic centimeter, the size of a small sugar cube, could be spread across 10 U.S. football fields worth of silicon wafers used to make chips.

"That assumes a 50-atom-high pile of it," said Meyerson, "which frankly would be an extraordinarily large amount for materials like this one. That amount will go down over time."

The material layered into transistors is alloy hafnium oxide, which means pure hafnium would stretch even further.

When working on such a minute scale, electricity tends to leak out of transistor circuits, resulting in power loss, and the silicon oxide material that hafnium replaces also leaks power. The new hafnium chips help reduce that power loss and

lets chipmakers create ever smaller processors.

"The advantage of a small processor is it's faster and lower power, meaning your battery life will be longer," said Professor Tso-Ping Ma, chairman of electrical engineering at Yale University and a 10-year researcher on the new chips.

"You won't need to recharge your cellphone or Blackberry or laptop as often. If you can lengthen the battery life by a factor of two, that is tremendous. And that's what this thing does," he added.

The hafnium-based semiconductor runs 20 percent faster, Ma said, and reduced leakage will mean five times the power savings.

NO FIGHT OVER SUPPLIES SEEN YET

Each year, only 50 tonnes of hafnium is produced. It never occurs as a vein in the earth so refiners must extract it as a byproduct of zirconium oxide, a fairly abundant metal prevalent in the U.S., Brazil, Australia, Russia and China.

Their nearly identical atomic structures renders hafnium difficult and costly to separate from zirconium and much depends on the zirconium deposit's quality. About 60 percent to 70 percent of the world's hafnium supply now goes into nuclear control rods, with most of the remainder used in high-specification jet engine metals.

Hafnium watchers were not fearful of competition for supplies, at least in the near term.

"Given the amounts we're using. We're not going to be fighting over sugar cubes," quipped IBM's Meyerson.

Still, according to Los Angeles-based American Elements, a leading rare earth elements producer, existence in the earth's crust does not necessarily mean the material is minable.

For example, said American Elements President Michael Silver, radioactive problems plague Australia's deposits and in Florida they occur scattered in beach sand.

"In the Florida sands there's a substantial amount of rare earth, but there's no way in the world you're going to be able to refine it. It would never be cost effective," he said.

American Elements, which makes about a ton of hafnium a year for customers like General Electric and Siemens as well as the new chip designers, has been producing hafnium for about 10 years at its facility in China, where most of the world's viable supply exists.

An oft-cited quote by former paramount leader Deng Xiaoping, "The Middle East has oil and China has rare earth," illustrates China's proprietary position on its rare elements.

By imposing ever stricter export restrictions, the Asian giant has been pressuring international industries to refine rare metals in China. Last month, Silver said, China slapped a 10 percent export charge on all rare earth materials.

"It's now more cost effective to set up a separation plant in China. You can't afford to ship metal oxide anymore. You would eat up your quota very quickly," Silver added.

So far, Silver said he has not seen supply pressures on hafnium. But that may change in the long run.

"Until more pressure is put on demand for hafnium, I don't think you're going to truly know what the capacity is for cost effective, minable hafnium. We simply haven't been tested."