

Silicon on insulator's new momentum

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Once relegated to the relative obscurity of space, aviation and other high-radiation environments, silicon-on-insulator (SoI) technology has made up a tiny portion of the total wafer market share to date—just 3 percent in 2004, according to Semiconductor Equipment and Materials International (SEMI). These kinds of low-volume, high-cost applications fit with the substrate's reputation as a specialized, expensive alternative to wafers manufactured in bulk.

SoI is a type of wafer that includes an insulator layer, making it ideal for high-radiation environments, because chips that are built with it experience fewer soft errors (that is, particle interference that changes 0s to 1s, and vice versa). But the substrate also offers regular chip makers a significant advantage—increased speed-while consuming considerably less power. As companies have engaged in the Moore's Law race to scale down their advanced parts to .13 microns and 90 nm and are now moving to 65 nm, it has become increasingly difficult to achieve greater performance for the power.

"SoI is clearly solving one of the key issues the industry is facing: power consumption and heat," says Andre Auberton-Herve, CEO of Soitec, which holds an 80 percent market share in the SoI space. "The more you scale, the hotter you get. SoI has proven to be a key solution for breaking this thermal wall."

With that in mind, a couple of the big names in processors started dipping their toes into the water of SoIs a couple of years ago. Apple Computer has built its G4 and G5 Macintosh computers on SoI-based chips, bringing the technology to the consumer market for the first time. And now some chip companies—IBM; AMD; and to a lesser degree, Freescale Semiconductor —have indicated that they are ready to make big commitments to SoI.

In mid-January, AMD and Soitec announced a multiyear supply deal that calls for AMD to buy \$50 million worth of 200-mm and 300-mm SoI wafers in 2005 alone. Indeed, AMD plans to build all of its microprocessors on SoI substrates from now on.

"Every AMD64 chip we've shipped has been on SoI," says Nick Kepler, vice president of logic technology development at the microprocessor maker. As AMD's 64-bit volume has ramped up, so has its use of SoI. The company began exploring the technology in the late 1990s, as developers recognized that power would soon become an issue. "We felt confident that SoI would give us a better performance-to-power ratio," Kepler says.

SoI has also found a huge supporter in IBM, which has been using it for a few years now. And with support from a couple of the big players in microprocessors, SoI has begun to gain some mind share.

"Volumes started ramping up in 2004," says Trevor Yancey, vice president of technology at analyst firm IC Insights. "It takes some time for the transition and for new processes to get into volume production. Some momentum is shifting."

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In February IBM threw even more support behind SoI, with the announcement that its Cell processor codevelopment partnership with Sony and Toshiba would use SoI to build the chips. "That's a pretty big endorsement right there," says Joanne Itow, senior analyst with Semico Research.

The so-called superchip's prototype features supercomputer-like floating-point performance with observed clock speeds of greater than 4 GHz on 90-nm process technology, the companies say, which is well beyond what is available in any other processors today.

But not every chip maker has lined up behind SoI as the savior for scaling to smaller nodes. "There is definitely an SoI camp of companies that are using it at 90 nm and expect to use it at 65 nm," says Itow. "Then there is another camp that is still kind of pushing out [a decision on it] or not necessarily working it into volume production at this point." Intel and Texas Instruments are in this camp.

Detractors point to the cost of the material, which is higher than the cost of bulk wafers, and the complexity of developing for it. But proponents argue that in volume production, the cost per piece is only pennies more and that the performance it delivers is worth it.

"As a company, we had to learn SoI design techniques, manufacturing techniques and modeling," says AMD's Kepler. "All those things are more complicated in SoI. We did have a learning curve and some daunting tasks along the way, but as you can see, we have successfully climbed that curve. Now, if the whole industry moves to SoI, we've got a real advantage."

But the holdouts such as Intel and TI will need to sign on before SoI can grow in a really big way, analysts agree. "As so many manufacturers reach higher volumes, SoI will grow," Yancey says, "but the microprocessor business is dominated by Intel, so there won't be a substantial shift in market share to SoI unless Intel decides to start using it."

That may actually be down the road. According to Yancey, Intel has spoken of a technology it calls Terahertz, described as a "depleted substrate transistor." "That is SoI, but Intel would never use the term," Yancey says. "I think you will see more and more microprocessors being made on SoI as power consumption becomes a more critical issue."