OmniVision adopts backside illumination technology for CMOS imager

Junko Yoshida - May 27, 2008

MANHASSET, New York — The dilemma of shrinking pixel size in CMOS image sensors’ without degrading performance and image quality is the big hurdle today in the steeplechase among at least a half-dozen competitors to miniaturize digital imaging technology.

OmniVision Technologies, Inc., the largest CMOS image sensor manufacturer today, believes it has found an answer in a novel design that adopts backside illumination (BSI) technology.

Together with Taiwan Semiconductor Manufacturing Corp. (TSMC), OmniVision developed "process tweaks" that allow OmniVision to offer a CMOS sensor with improved image quality while extending its pixel roadmap down to 0.9 micron pixels, according to the company.

OmniVision said that it’s ready to start sampling next month an 8-Megapixel product using the new BSI-based sensor design called OmniBSI.

But to describe it as a development that "turns the imaging world upside down," as indicated in a press release (issued today), borders on hyperbole. The BSI technology concept is not proprietary to OmniVision and there is every indication that OmniVision's competitors may be catching up.

BSI itself is not a novel concept.

A quick search on the Internet reveals that several related patents have been already granted to companies, including OmniVision's competitors.

They include: "Backside illumination of CMOS image sensor"; "CMOS image sensor with backside illumination and method for manufacturing the same"; "Methods of avoiding wafer breakage during manufacture of backside illuminated image sensors." The first one (United States Patent 6429036 ) is held by Micron Technology, Inc., the second (United States Patent 20070152250) by MagnaChip; and the third (United States Patent 20080044984) by TSMC.

To be fair, OmniVision was quick to acknowledge that backside illumination concepts have been studied for over 20 years. "But we are the first to turn the 'science project' into a process technology," thus taking it to mass production, said Michael Hepp, product marketing manager at OmniVision, in an interview with E.E.Times.

The BSI concept is straightforward. Instead of illuminating a CMOS image sensor from the top (front) side of the silicon die, backside illumination collects photons from the backside of the pixel area. By eliminating obstacles — such as many metal and dielectric layers " which tend to obscure the pixel area, BSI helps stop the loss of photons and maximize the area in which photons are collected.
Advantages of BSI-based sensor design include: improved light absorption; thinner camera modules (due to lower stack height); increased sensitivity and F stops; and reduced crosstalk. **What's been the hold up?**

Anu Pokharna, researcher at iSuppli, said, "This [BSI] has been around in the CCD industry for quite some years especially in the high-end cameras for space programs, astronomy, and scientific imaging." Pokharna added, "Basically it's been used in applications which require extremely high performance." The technology, however, has never trickled down to consumer applications, because "the cost differential has been a factor of 2 to 3 times more."

Tony Henning, senior analyst at Future Image Inc. (San Mateo, Calif.), pointed out that Micron filed a patent on BSI in 2000. He observed, "I suspect that while the concept has been well understood for years, actually making it work — in sufficient quantities (hundreds of millions), and maintaining acceptable quality standards and, of course, a low manufacturing cost — has required a combination of multiple improvements in materials and processes that has taken years to achieve/perfect." He added, "OmniVision says they and TSMC have been working on it steadily for two years."

Nonetheless, how they did it — what exactly TSMC and OmniVision jointly developed to make this happen — remains a mystery.

OmniVision executives declined to offer specifics, either on its newly developed technology or on business arrangements. For example, will the newly developed process technology at TSMC become available for other CMOS image sensor vendors? OmniVision would not say.

OmniVision's Hepp characterized what OmniVision and TSMC have developed as "process tweaks" rather than a new process technology. Such tweaks include "grinding silicon," because the thickness of a typical silicon wafer needs to be thinned considerably in order to absorb the photons in the sensitive area, and "optimization of tools," explained Hepp.

Future Image's Henning said that OmniVision was no more forthright with him or anyone else outside the company on details of their invention. "I suspect that it really boils down to a series of small steps that resulted in a cumulative improvement sufficient to allow them to commercialize their implementation," he said.

But why such secrecy?

Henning speculated: "I would be willing to wager that many of the process tweaks are not covered by patents or other IP protection and are, in theory, available to anyone willing to invest the time and expense necessary to develop them. That's no doubt why OmniVision is unwilling to be more specific about what these tweaks are."

It remains unclear who else might be working on BSI-based CMOS image sensors today and what progress they might have made.

Reportedly, MagnaChip earlier this year at the Mobile World Congress in Barcelona showed off new mobile phone camera sensor technologies, including backside illumination. The technology demo, however, was said to have been limited to only black and white. Industry analysts suggest that Kodak and Micron (now Aptnia) may be also working on BSI.

**Competing technologies to help reduce pixel size**

Of course, BSI is not the only way to skin this particular cat. Last June, Kodak, for example, unveiled a new color-filter technology, which almost doubles the sensitivity to light of the image sensor. It adds panchromatic pixels to the red, green and blue elements of the color filter array. (see:  [Kodak](#))
Henning adds Tessera among developers of BSI alternatives. Tessera has built "a strong technology portfolio in this space by acquiring a variety of companies," he said. "Their packaging technologies (from Shellcase and Digital Optics) enable wafer-level cameras (smaller, cheaper)."

How heavily will OmniVision's OmniBSI affect CMOS image market competition?

iSuppli remains cautious. Pokharna said, "We feel it will not address the mass market right from the start because of the cost." However, "This technology at least in the near future will make some inroads in the high-end camera space where low light detection will be important, and where you need the ability to take better images in spite of shorter exposure times," added iSuppli.

OmniVision is not yet unveiling the price of its upcoming 8Megapixel product using BSI.

But with the OmniBSI architecture, the company claims that it's ready to take on the most advanced pixel size this summer. OmniVision is building a 1.4 micron BSI pixel that "surpasses all the performance metrics of 1.4 micron, and even most 1.75 micron front side illumination pixels," according to the company.

1.75 micron is the state of the art of pixel size on the CMOS image sensor market today. By this summer, 1.4 micron pixel technology should be in production, according to iSuppli.

OmniVision believes BSI will become an even more important differentiator in the future. Today, OmniVision can continue to use TSMC's proven 110nm process technology, at a time when front side illumination (FSI) pixel technology would require a migration to 65nm process technologies. This is because when one moves FSI pixel architecture down to 1.4 micron or below, metal lines and transistors are driving the aperture of the pixel close to the wavelength of light, its physical limit, according to OmniVision.

"Our advantage [in using BSI] is in that we can continue to utilize older process technologies in a fab, while still creating a CMOS image sensor with a smaller pixel size," said Hepp.

OmniVision last year became the largest CMOS image sensor manufacturer with a 19 percent share. Micron lost the helm, moving down to third place at 16.1 percent, according to iSuppli.

Struggling Micron earlier this year launched Aptina Imaging, a separate, independent CMOS Image sensor division, setting the stage for a possible spinout of that business. Aptina will be free to seek manufacturing alliances with outside foundries. The captive business unit had relied solely on Micron for its manufacturing needs. (see: Micron's loss widens amid flat sales)