OmniVision's VGA wafer-level camera

Whether it's for the main camera of low-cost phones or the front-facing camera of high-end phones, low-cost, low-resolution camera modules are extremely important.

Wafer-level cameras

In order to manufacture low-cost camera modules, the main cost drivers -- the image sensor, the optical module and the fixture used to assemble the module to the phone board -- have to be reduced to a strict minimum.

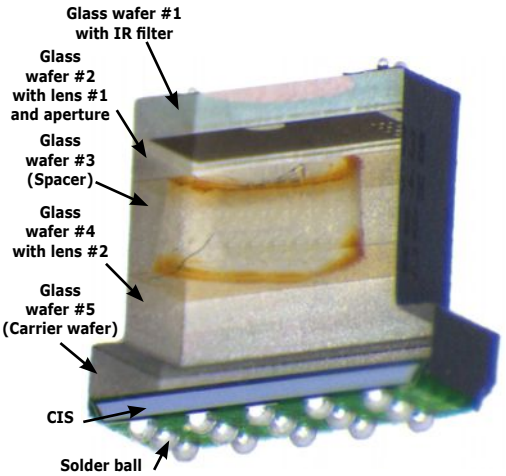
The image sensors lend themselves rather well to low-cost manufacturing due to their wafer-level manufacturing approach. With this approach it is possible to manufacture optical lenses at the wafer-level, thus creating a very low-cost wafer-level optical module (or wafer-level optics, WLOptics). Another benefit of WLOptics is their reflow-compatible materials. By eliminating the plastic lenses used in standard optical modules, the camera modules become compatible with reflow soldering, and thus can be integrated at the same time as the other surface mount components on the phone board.
One way to optimize this reflow compatibility is to package the image sensor at the wafer-level by redistributing the pads to the back side. This also reduces the camera module area to the image sensor area.

OmniVision CameraCube

A pioneer of the CMOS Image Sensor industry, OmniVision released its latest wafer level camera, the OVM7692, in 2010.

OmniVision OVM7692 CameraCubeChip™ (Courtesy of System Plus Consulting)

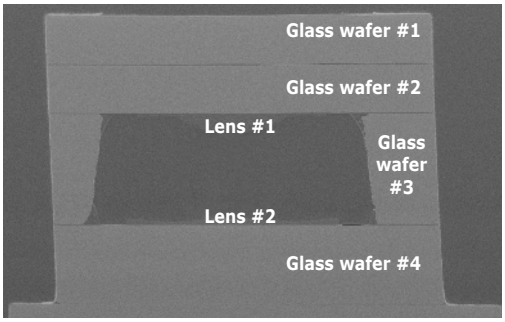
The OVM7692 is a VGA reflowable camera module which integrates a Wafer-Level Packaged CMOS Image Sensor and Wafer-Level Optics. The camera module is provided in a 2.8 x 3.2 x 2.5 mm 25-pin package, and integrates a 1.75µm pixel CMOS Image Sensor (CIS), ref. OV289AA from OmniVision, which is manufactured by TSMC using a CMOS technology with a 0.11µm process.



OmniVision OVM7692 cross-section (Courtesy of System Plus Consulting)

Wafer-level optics

The wafer-level optical module of the OVM7692 is currently outsourced to VisEra Technologies in Taiwan. VisEra was founded in December 2003 as a joint venture between TSMC and OmniVision. On June 30, 2011, OmniVision paid $45M for VisEra's WLOptics manufacturing operations, and expects to close the transaction in the second quarter of 2012. According to OmniVision, this transaction will allow for streamlining the production process, consolidating the supply chain, expanding the production capacity and reducing the cost.



OVM7692 Wafer-level optics cross-section (Courtesy of System Plus Consulting)

The WLOptics of the OmniVision CameraCube consists of an assembly of four glass wafers.

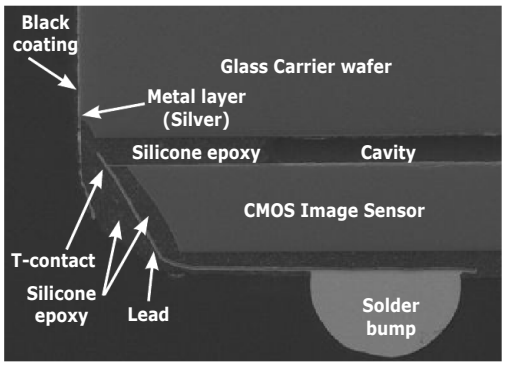
The first glass wafer, on top of the module, holds an IR filter (consisting of layers of Niobium oxide sandwiched with layers of Silicon oxide). The second glass wafer holds the first lens. Next up is a spacer glass wafer, etched by powder blasting, which separates the second glass wafer from the fourth glass wafer -- which holds the second lens. The lenses are made with a UV curable polymer and are manufactured with a replication process. A plastic tool (likely Polydimethylsiloxane --PDMS silicone) molded into a master is used to imprint the polymer lenses. Each master can be used to make a large number of PDMS tools, and each PDMS tool can be used to imprint a large number of lenses.

Wafer-level packaging

The CMOS Image Sensor (CIS) is Wafer-Level Packaged (WLP) by Xintec, using a ShellCase RT process.

Xintec obtained a license for the ShellCase CSP technology from ShellCase Ltd. in 2000 (Tessera has since acquired ShellCase Ltd. and now licenses the ShellCase technology to Xintec). The ShellCase process consists of a redistribution of the CIS pads to the back side through the edge of the die, using a "T-contact".

The packaging process begins with the bonding of a glass carrier substrate to the CIS wafer. Strengthened by its carrier substrate, the CIS wafer



OVM7692 ShellCase CIS WLP cross-section (Courtesy of System Plus Consulting)

can be thinned down to 130µm, and vias can be etched all around each CIS die. These vias are then filled with a conductive aluminum layer. Finally, a protective encapsulation is created and solder balls are produced.

Cost structure

Wafer-level manufacturing of all camera module elements results in a significant reduction of the production cost – in fact, the OmniVision OVM7692's total production cost is estimated to be under $1. Compared to standard camera modules where the cost is equally distributed between the three main cost drivers, the wafer-level camera module cost is especially impacted by the image sensor, which equates to about 50% of the total manufacturing cost.

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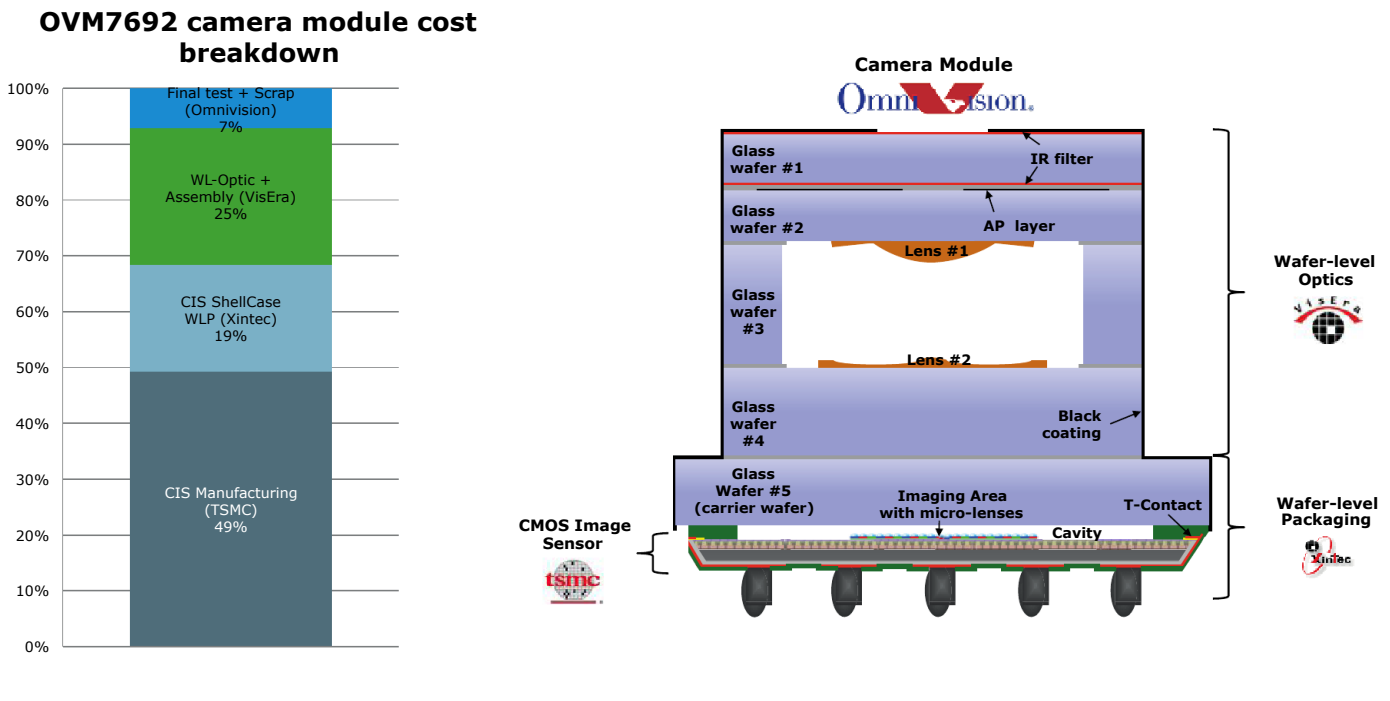

OVM7692 structure & cost breakdown (Courtesy of System Plus Consulting)