

High-Z Solid State Pixel Detector

Detector Packaging for Medical X-Ray Imaging and X-Ray Crystallography

Fast Facts

1. 65k pixels per chip in $55\ \mu\text{m} \times 55\ \mu\text{m}$ pitch
2. Electro-plating of Indium and Indium-Tin solder bumps
3. Low temperature bonding process for temperature sensitive High-Z sensor materials

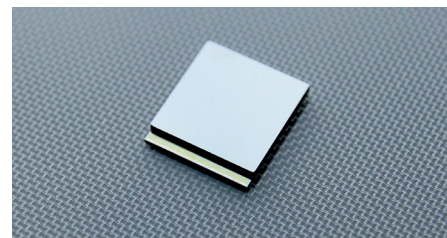
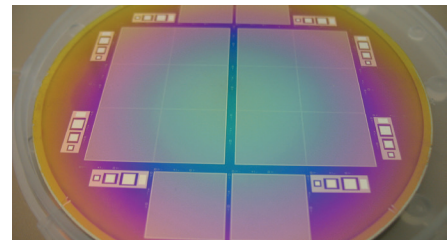
Hybrid pixel detector modules are state of the art components in X-ray cameras used in synchrotron radiation experiments and for X-ray imaging applications. In synchrotrons these photon-counting pixel detectors can be used for basic research into X-ray crystallography and biomolecule structure. For medical applications they offer a wider dynamic range and higher resolution than film based or scintillator based X-ray detectors at much lower dose.

The basic elements of pixel detectors are hybrid modules which consist of a particle sensing element, the solid state sensor, and one or more electronic readout chips which are flip-chip bonded to the sensor. Besides pixelated silicon sensors, so-called high-Z sensor materials such as CdTe, CdZnTe, Ge, and GaAs are also used, especially for the detection of hard X-ray radiation.

In order to electrically connect every cell of the electronic readout chip with the corresponding sensor pixel cell, micro solder bumps and solderable pad metallization are deposited onto these elements at wafer level. This wafer level packaging process includes sputtering of a plating base layer, thin film lithography with characteristic size of about $20\ \mu\text{m}$, and the deposition of solder bumps by electroplating.

Besides standard SnAg solder bumping, there is also a focus on low melting-point solder bumps such as Indium or Indium-tin especially for temperature-sensitive high-Z sensor materials. In the subsequent assembly process the electronic readout chips are flip-chip bonded onto the sensor chip either by reflow soldering or by thermocompression bonding. The final integration into the X-ray camera including setup and calibration is done customer side.

New developments in this business focus on 3D TSV integration in electronic readout chips and the assembly of so-called edgeless sensor chips. Thereby the modules of the detector can be placed very closely together with minimal areas of insensitivity between adjacent pixel detector modules. This will result in a larger sensitive detector area with almost no gaps and loss of information in the detected image.



Top: High-Z material (GaAs, CdTe, Ge) sensor chip wafer for X-ray camera module assembly

Bottom: Hybrid X-ray detector module with CdTe sensor chip; 65kPix single chip module with pixel pitch of $55\ \mu\text{m}$

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