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Indium Bump Deposition Techniques on Wafers and Individual Die Chips for Flip-Chip Bonding of Hybrid X-ray Detectors

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Flip-chip bonding is a common method for joining ASICs to pixelated sensors in order to build hybrid X-ray detectors. STFC-RAL is using two methods for the interconnects between ASIC and sensor pixels. These are either indium bumps which are deposited on ASIC and sensor prior to bonding or alternatively electrically conductive adhesive dots are printed on the sensor pixel array and flip-chip bonded to gold studs attached to each pixel of the ASIC.
Conventionally the indium deposition is carried out on wafer-scale using a photolithographic lift-off process [1]. Sensor and ASIC with indium bumps are singulated from wafers afterwards.
However, some sensor material (e.g. CdZnTe) which is required for high-energy and high-flux X-ray detectors at XFEL or other scientific experiments is only available as individual die instead of wafers. The stencil printing of conductive epoxy dots onto those sensor dies together with gold ball studding of ASICs is a suitable method for those dies [2]. However, due to the size of printed epoxy dots this method has a limited pixel pitch and is currently only used down to 250µm-pitch. A novel method for indium deposition was developed for such dies. A shadow mask with small apertures is optically aligned to the pixel array and mechanically clamped to the sensor die. After indium evaporation onto this assembly and after removal of the mask, indium bumps as small as 50µm with a height of ˜5µm are deposit onto the pixel array of the sensor. The same is done for a matching ASIC. Fig. 1 compares these two methods and indicates that indium bumps created by this method are approx. half the size of the epoxy dots and comparable with gold studs.
This novel indium deposition method will be compared with the conventional wafer-scale indium lift-off method and the epoxy/gold stud flip-chip bonding in terms of interconnect quality, bond yield, and suitability for hybrid X-ray detectors.

[1] C. Broennimann et al., Nuc. Inst. & Meth. In Phys. Res. A 565 (2006), 303-308
[2] A. Schneider et al., JINST 10 (2015), C02010
[3] W. Decker et al. Society of Vacuum Coaters 59th Ann. Tech. Conf. (2016) 95-100

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