



Contribution ID: 138

Type: ORAL

Development of KEK/HPK Planar p-type Pixel Sensor and Lead-free Bumpbonding for HL-LHC

Tuesday, 2 September 2014 14:00 (25 minutes)

We have been developing a planar-process pixel sensor in p-type 6-in. silicon wafer for an application in ATLAS detector for the luminosity upgrade of the large hadron collider (HL-LHC). Our motivation is to develop highly radiation-tolerant and cost-effective sensors for covering large area of the pixel detector. After irradiations and beamtests, inefficient regions in detecting passing-through charged particles in pixel structures were identified in the 1st prototype pixel sensors. The 2nd prototype sensors with new pixel structures were fabricated and are shown to improve the inefficiency associated with the bias rail greatly.

The pixel sensor are readout with an ATLAS pixel readout ASIC FE-I4 being bumpbonded. The bumpbonding has been successful for a thick sensor and a thick ASIC with a Lead-free (SnAg) solder bumps. In reducing the material, usage of thin sensors and thin ASIC's are envisaged. The difficulty associated with the thin sensor and ASIC's was experienced and the sources of difficulty have been identified. The latest bumpbonding has been successful by improving the flatness of the thin ASIC's and the vacuum chucking area of both the thin sensor and the ASIC's.

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Session Classification: HL-LHC/LC Sensor Developments