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Novel production method for large double-sided microstrip detectors of the CBM Silicon Tracking System at FAIR

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The detector module of the Silicon Tracking System (STS) of the Compressed Baryonic Matter (CBM) experiment at FAIR (GSI) consists of double-sided silicon microstrip sensors with a size up to 124 mm x 62 mm which are connected to the read-out electronics by flexible microcables. The production of the detector modules faces several challenges. A new multilayer copper microcable with low material budget has been designed to achieve low mass and low capacitance up to 50 cm length. We present the detector production method based on novel high-density gold-stud bump-bonding technology of silicon die on microcable.

Summary

The CBM experiment at the Facility for Antiproton and Ion Research (FAIR) in Darmstadt, Germany, aims to explore the quantum chromodynamics (QCD) phase diagram for high baryon densities. One of the core detectors of CBM is the Silicon Tracking System (STS). It consists of eight tracking stations of double-sided silicon microstrip detectors. Each sensor contains 2048 strips, 1024 strips for n- and p-side, respectively. Sixteen STSXYTER readout ASICs with 128 channels each are connected to one sensor. Because the very low material budget requirements, the front-end electronics are located far from the sensitive sensor region and therefore connected by a novel low-mass copper flex microcables. With a pad pitch of 116 µm and a lead width of 30 µm, the specifications of the microcable are at the limit of modern fabrication technology.

The KIT production approach establishes a novel interconnection technology which might be of interest also for other future detectors. It combines low cost and high parallelization capability with good mechanical and electrical reliability.

Solder paste type 7 with grain sizes ranging from 2-11 µm is stencil-printed on 140 µm x 50 µm bond pads on the microcable. Two rows of 64 pads enable the connection of the 128 channels. Gold-stud bumps with a diameter of 55 µm are placed on both the readout ASIC and the sensor. In the subsequent flip chip process, gold-bumped ASICs are directly bonded on the microcables and reflowed in a dedicated oven under formic acid atmosphere. Eight microcables to ASICs structures are then placed next to each other on one side of the sensor. To guarantee high accuracy in the bonding process as well as high throughput an in-house bonding machine is under construction. After bonding the top side of the sensor, the complete structure has to be flipped to allow bonding of eight more microcables on the bottom side.

To ensure proper spark protection between the HV sensor and the LV microcable as well as a strong mechanical connection, an underfill has to be applied on the outer rim of the sensor by a controlled dispenser. The module is completed by wire-bonding the ASICs onto two FEB-8 front end boards.

The novel production steps of the double-sided silicon detectors and preliminary electrical test results will be presented.

Author: PFISTNER, Patrick (KIT)

Co-authors: Prof. WEBER, Marc (KIT); CASELLE, Michele (Karlsruhe Institute of Technology); BLANK, Thomas (KIT)

Presenter: PFISTNER, Patrick (KIT)

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