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The micro-RWELL detector

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Abstract

The R&D on the micro-Resistive-WELL (μ-RWELL) detector technology aims in developing a new scalable, compact, spark-protected, single amplification stage Micro-Pattern Gas Detectors (MPGD) for large area HEP applications as tracking and calorimeter device as well as for industrial and medical applications as X-ray and neutron imaging gas pixel detector. The novel micro-structure, exploiting several solutions and improvements achieved in the last years for MPGDs, in particular for GEMs and Micromegas, is an extremely simple detector allowing an easy engineering with consequent technological transfer toward the photolithography industry. Large area detectors (up 1x2 mˆ2) can be realized splicing μ-RWELL_PCB tiles of smaller size (about 0.5x0.5 mˆ2 –typical PCB industrial size). The detector, composed by few basic elements such as the readout-PCB (embedded with the amplification stage through the resistive layer) and the cathode defining the gas drift-conversion gap has been largely characterized on test bench with X-ray and beam tests.

Summary

The micro-resistive WELL (μ-RWELL) detector is a compact, spark-protected, single amplification stage Micro-Pattern Gas Detector (MPGD). The new micro-structure exploits several solutions and improvements implemented in the last years for MPGDs, in particular for GEMs and Micromegas. The μ-RWELL, based on the resistive technology concept leading to very efficient spark quenching, is a high reliable device. In addition, since does not require any complex and time-consuming assembly procedures (neither stretching nor gluing), it becomes extremely simple to be assembled. These features allow for an easy engineering of the detector opening the way towards industrial applications.
The detector is composed by only two elements, i.e. the readout-PCB, embedded with the amplification stage (the core of the detector, named μ-RWELL_PCB) and the cathode. The amplification stage of the detector, realized by photolithography as a matrix of wells (with a pitch of 140 μm and a diameter of 60-70 μm) on a 50 μm thick polyimide substrate, is embedded through a resistive layer with the readout board. The resistive layer can be realized by means DLC (Diamond Like Carbon) dry sputtering technology. The required surface resistivity, typically ranging from tens to hundreds MΩ/square, is clearly a crucial parameter that must be optimized as a function of detector performance, such as rate capability, charge spread on the readout electrodes, spark quenching and maximum achievable gain. A cathode electrode, defining the gas conversion-drift gap, completes the detector mechanics. The detector has been characterized on test bench with X-rays and its tracking performance measured on several beam test in different conditions. The device, robust against discharges, can be operated in a safe mode at a gas gain up to 10ˆ4, a rate capability up to few MHz/cmˆ2 (achieved for particular scheme of the resistive layer) and a space resolution down to 60 μm. The μ-RWELL technology, under development with industrial partners, is suitable for large area tracking devices and can be exploited as active device in digital hadron calorimetry in HEP experiments: the detector, recently proposed for the phase-2 upgrade of CMS and LHCb muon apparatus as well as for the neutrino detector of the SHIP experiment, is a technology suitable also for the muon apparatus at future colliders (CEPC, SppC and FCC – hh).

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