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Towards the complete realization of a coaxial and segmented detector for gamma spectroscopy experiments

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The higher counting-rate and radiation hardness required by modern gamma spectroscopy experiments highlight the need for a new generation of High-Purity Germanium (HPGe) detectors based on electrons-collecting electrodes. To achieve this goal, a new doping technology, the Pulsed Laser Melting (PLM), has been developed. This technique is being applied to coaxial detectors in the framework of the N3G (Next Generation Germanium Gamma detectors) project which is also aimed at developing a case able to contain and protect the detector and at designing its contact structures and front-end electronics.
Once the doping is realized on the detector surface, a thin (less than 100 nm) layer of gold is deposited by sputtering. This layer is necessary to segment the realized junction, since it is resistant to the acid etching of germanium. Then the photolithography segmentation process is performed. A positive photoresist is deposited on top of the gold layer and an acetate mask is used to protect the electrodes from the UV irradiation. After the irradiated photoresist is removed, a gold etching is done to remove the gold between the segments. Finally the detector is chemically etched to remove the junction diffusion on the gap and quenched with a methanol passivation.
The electrical connection of the electrodes is made possible by a flower-shaped PCB (Printed Circuit Board). This solution doesn't scratch the brittle surface of the detector and works properly at cryogenic temperatures. Furthermore it decreases the detector leakage current with respect to the connection-systems previously used. This flexible PCB is than connected through a rigid one to the read-out electronic chain.
The detector and the electrical connections are housed into a vacuum-tight canister, made by an aluminum cylindrical case closed by a stainless steel flange. This system contains and protects the detector and makes it possible to operate in high-vacuum condition. Moreover the whole mechanics is compatible with the cryostats available from LNL (Laboratori Nazionali di Legnaro).
The detector, its mechanics and its electronic connections have been assembled and tested. Of the available segments, the current-voltage curves were extracted together with the resistance between adjacent electrodes themselves. Segments resulted well isolated from each other (resistances on the order of $10^{12} - 10^{13}$ Ω) and the flexible PCB applied didn't scratch their surface . Moreover, part of the electrodes showed a leakage current on the order of $10^{-12} - 10^{-11}$ A, several orders of magnitude lower than the one measured with typical contact structures.

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