9th International "Hiroshima" Symposium on the Development and Application of Semiconductor Tracking Detectors, Hiroshima, Japan

Contribution ID: **4** Type: **ORAL**

Development of Novel On-Chip, Customer-Design Spiral Biasing Adaptor on for Si Drift Detectors And Detector Arrays for X-ray and Nuclear Physics Experiments

Monday 2 September 2013 11:30 (20 minutes)

A novel on-chip, customer-design spiral biasing adaptor (SBA) has been developed at BNL. The SBA can be used for biasing a Si drift detector (SDD) and SDD array. The SBA concept has the following novel characteristics and advantages: 1) it is customer-design for any desired geometry of SDD single cell with minimum current and minimum drift time of carriers; 2) it has the spiral shaped ion- implants that define the desired voltage profile according to calculations; 3) the radius dependence of the pitch (pSBA(r)) of the spiral is the same as that of the SDD single cell (pSBA(r))=pSDD(r)), which in general varies with radius; 4) the width of the implanted spiral (WSBA(r)) that varies with radius does not have to equal to that of the SDD single cell (WSBA(r)^{1}WSDD(r)), and can be made small to minimize the current in the SBA; 5) it is processed on the same wafer of SDD and SDD array; 6) only one SBA chip/side is needed for one SDD or SDD array to define the voltage profiles on the front side and backside (two SBA chips for double-side SDD array, one SBA chip for SDD array with uniform backside bias); and 7) the connection of the SBA chip and the SDD array can be either double metal (most convenient, SBA and SDD are attached) or wire bonding (SBA chip can be diced off from the SDD array, no heat on the SDD array). The geometry of a single SDD cell is defined by concentric rings of ion-implants (pSDD(r)=pSBA(r)) with maximum width (WSDD(r))>WSBA(r)) to minimize surface current. The surface potential profiles of the leading single SDD cell are defined by the SBA chips provided by wire bond or second metal interconnections, while those of the rest of single SDD cells in the array are provided by the interconnections (second metal, or in some simple cases, wire bonds) of corresponding rings among the single SDD cells (including the leading one). The interconnections between the SDD single cells in most cases are double-metal ones. For cases with small array and small number of rings (small cells), wire bonding may be doable and desirable for interconnections between single SDD cells. In this new SDD array, minimum or no heat generated by SBA will affect the SDD array, and the power consumption of the new SDD array is reduced by a factor of NxM as compared to the conventional spiral SDD array. The new SDD array with SBA can be used for x-ray and for nuclear physics experiments.

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Session Classification: Session 1

Track Classification: Simulations and Manufacturing