High-speed Position-Sensitive Devices: Theory and Experiments.

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Desirability for measurement of the correct high-speed radiated-position becomes important in many applications. Using a conventional position sensitive device (CPSD), the radiated-position can not be measured accurately. For measuring the fast radiated-position, I studied from two directions: (i) the development of the new generalized model for the one-dimensional (1-D) and two-dimensional(2-D) CPSDs to predict the performance characteristics in the high-speed incident position measurement and (ii) the proposing of novel structures for high-speed PSDs (HPSD).

The generalized models for the 1-D and 2-D CPSD are derived based on the wellknown RC-transmission line approximation. These model equations are used in the analysis and prediction of the dynamic performance of the very short-pulse (impulselike) excitation of 0.02 T_C for 1-D and 0.1 T_C for the 2-D CPSD, where T_C represents the time-constant of the PSD. Results show that 2-D CPSD is faster than the 1-D CPSD having the same area, and for impulse-like radiation measurements using 2-D CPSD, the position resolution is more degraded in the near electrode region than that of in the central region. The predicted results from the models are consistent with the experimental results.

After this essential work on the CPSD, we go on to study the HPSD by proposing novel structures. In concern with the HPSD, two novel structures are proposed. In the first, the CPSD response-speed is improved using a new structure. In the proposed PSD, the junction capacitance is reduced using a mesh-type resistive layer. This concept for improving the response-time is verified by fabricating the mesh-type PSD (MEPSD), and its response-time is compared with the CPSD fabricated using the same IC technology. Again, a theoretical based design strategy is proposed for investigating the effects of the principle design parameters on the device performances and to select the optimum design parameters. Results indicate that the MEPSD can be designed to operate one-to two-orders in magnitude faster than the CPSD. In the second, on study of the HPSD, a novel structure consisting of the matrixstructured photodetectors is proposed, which can detect the position binarily with the radiation. In the binary PSD (BPSD), each element is individually excited with the illumination and the response-speed is dependent on the speed of each element. For laboratory demonstration, an 8×8 matrix is chosen for the BPSD, fabricated using an a-Si technology and was verified the operation of the new BPSD.