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Abstract: Effect of photo-irradiation on the avalanche response time of Millimeter-wave (mm-wave) and Terahertz (THz) Double-Drift Region (DDR) Silicon Impact Avalanche Transit Time (IMPATT) devices is investigated in this paper. A model to study the photo-irradiation effect on the DC and high-frequency properties of the mm-wave and THz IMPATTs is developed by the authors based on which the simulation is carried out to calculate the avalanche response time of 94, 140, 220 GHz and 0.3 THz DDR Silicon IMPATTs under two different optical illumination configurations (Top Mount (TM) and Flip Chip (FC)). It is interesting to observe that the DC and high-frequency parameters of the device are more sensitive to electron dominated photo current (TM structure) compared to the hole dominated photo current (FC structure). Results show that the avalanche response time of the device decreases due to optical illumination on both TM and FC structures and percentage of decrease in avalanche response time in TM structure is higher as compared to that in FC structure. Larger decrement of avalanche response time due to optical illumination in TM structure causes larger deviation of phase shift between RF voltage and terminal current of the device from 1800 which is the ideal phase difference between current and voltage for maximum RF power output; this is the main cause of greater reduction in RF power output in TM structure compared to FC structure due to optical illumination.

Keywords: Avalanche response time, DDR IMPATT device, Flip chip, Top mount, Terahertz regime.