Perancangan dan simulasi nanoscale-based single photon avalance diode on silicon = Design and simulation nanoscale-based single photon avalanche diode on silicon

Dedy Septono Catur Putranto, author

Abstrak

ABSTRAK
Sampai saat ini riset untuk aplikasi single photon timing dan single photon counting masih terus dilakukan. Dalam perkembangan riset di bidang single photon detector dan single photon generation juga terus dilakukan, salah satu single photon detector berbahan silikon yang paling pesat perkembangannya adalah Single Photon Avalanche Diode (SPAD). Riset terakhir mengenai SPAD dengan luas aktif area sebesar 120 nm menghasilkan timing response detektor sebesar 144 ps. Untuk menghasilkan rancangan struktur SPAD berbahan silikon dengan timing response dibawah 144 ps, maka pada tesis ini akan dirancang dan disimulasikan SPAD berskala nano untuk memperkecil aktif area.
Landasan perancangan adalah hetrostructure silicon nanowire berdiameter 20 nm dengan struktur p-i-n sehingga diharapkan pada daerah deplesi akan terjadi peningkatan carrier generation. Dengan demikian proses distribusi avalanche oleh carrier generation setelah pemicuan foton tunggal semakin cepat sehingga timing response akan semakin cepat. Perhitungan timing response dipengaruhi oleh empat parameter, yaitu probabilitas foton yang diserap pada daerah netral
( ), waktu respon yang dibutuhkan elektron pada daerah deplesi untuk
berdistribusi ke daerah sensitif detektor ( ), Fungsi dan waktu difusi
terbatas untuk carrier photogenerated di daerah netral ( ). Dari analisa hasil simulasi perancangan terbukti bahwa dengan memperkecil
luas daerah aktif SPAD dan membuat struktur p-i-n akan memperlebar daerah deplesi akan mempercepat timing response divais menjadi 30 ps sesuai dengan simulasi menggunakan MATLAB.
<hr>
ABSTRACT
Nowadays researches for single photon timing and single photon counting application still continuosly done. Concerning the research development in field of single photon detector and single photon generation is constantly also made, one of silicon single photon detector the most rapid development is Single Photon Avalanche Diode (SPAD). Recent research on the SPAD with an active area of 120 nm produces timing detector response of 144 ps. To produce silicone SPAD structure design with the response below 144 ps timing, so in this thesis will be
designed and simulated nanoscale-based SPAD in order to reduce the active area.
The foundation design is hetrostructure silicon nanowire 20 nm in diameter with p-i-n structure which is expected in the depletion region will increase the carrier generation. Thus the process of distribution by the carrier avalanche generation after a single photon triggers the faster so that timing will be more rapid response. Calculation of response timing is influenced by four parameters, the probability of a photon is absorbed in the neutral region ( ), response time it takes electrons in the depletion region for distribution to the detector sensitive area ( ), function and diffusion time is limited to carriers photogenerated in the neutral

region ( ). From the analysis of the design of the simulation?s result, proved that by minimizing the SPAD active area and create a pin structure will widen the depletion region will accelerate the timing of the response device to be 30 ps according to the simulation using MATLAB.;Nowadays researches for single photon timing and single photon counting application still continuosly done. Concerning the research development in field of single photon detector and single photon generation is constantly also made, one of silicon single photon detector the most rapid development is Single Photon Avalanche Diode (SPAD). Recent research on the SPAD with an active area of 120 nm produces timing detector response of 144 ps. To produce silicone SPAD structure design with the response below 144 ps timing, so in this thesis will be designed and simulated nanoscale-based SPAD in order to reduce the active area.
The foundation design is hetrostructure silicon nanowire 20 nm in diameter with p-i-n structure which is expected in the depletion region will increase the carrier generation. Thus the process of distribution by the carrier avalanche generation after a single photon triggers the faster so that timing will be more rapid response. Calculation of response timing is influenced by four parameters, the probability of a photon is absorbed in the neutral region ( ), response time it takes electrons in the depletion region for distribution to the detector sensitive area ( ), function and diffusion time is limited to carriers photogenerated in the neutral region ( ). From the analysis of the design of the simulation?s result, proved that by minimizing the SPAD active area and create a pin structure will widen the depletion region will accelerate the timing of the response device to be 30 ps according to the simulation using MATLAB.