

Ge-on-Si waveguide photodetectors: multiphysics modeling and experimental validation

Original

Ge-on-Si waveguide photodetectors: multiphysics modeling and experimental validation / Alasio, M., Goano, M., Tibaldi, A., Bertazzi, F., Namnabat, S., Adams, D., Gothoskar, P., Forghieri, F., Ghione, G., Vallone, M.. - ELETTRONICO. - (2021), pp. 37-38. (2021 International Conference on Numerical Simulation of Optoelectronic Devices (NUSOD) Turin, Italy 13-17 Settembre 2021) [10.1109/NUSOD52207.2021.9541424].

Availability:

This version is available at: 11583/2929020 since: 2021-10-04T17:59:38Z

Publisher:

IEEE

Published

DOI:10.1109/NUSOD52207.2021.9541424

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TABLE I
WPD GEOMETRY

	W_{Ge}	H_{Ge}	L_{Ge}	W_{doping}	W_{metal}	W_{taper}
Device 1	4 μm	0.8 μm	15 μm	3 μm	1.5 μm	2.0 μm
Device 2	2 μm	0.8 μm	15 μm	1.5 μm	1.0 μm	1.5 μm

III. RESULTS, COMMENTS AND CONCLUSIONS

Fig. 2 shows comparisons between numerical simulations and measurements of the two devices considered. All results correspond to a reverse bias voltage of 2 V, while the wavelength of the monochromatic source is 1310 nm. The optical power reaching the device is estimated starting from the output power of the laser test source and taking into account the typical losses in the input waveguide. The simulations assume an input optical power $P_{\text{opt}} = 200 \mu\text{W}$ (-6.98 dBm) at the end of the taper. This is compatible with the input optical power in the device measurements, where the measured laser output power is -1.89 dBm (647 μW), with estimated waveguide losses of 5 dBm. The measurements are from 10 MHz to 50 GHz; some noise is visible above 30 GHz. The experimental estimate of the cutoff frequency reported in Fig. 2 is an average of the measurements over all the nominally identical devices. The simulated and measured cutoff frequencies are in excellent agreement, with an absolute difference of about 2 GHz for Device 2 and even smaller for Device 1. This consistency between simulations and experiments suggests that the multiphysics model may indeed provide a better understanding of the device operation through the study of microscopic quantities such as the spatial distribution of the optical generation rate, that is reported in Fig. 3 as an average over the cross-section of the device along the z light propagation axis.

IV. ACKNOWLEDGEMENTS

This work was supported in part by Cisco Systems, Inc., under the Sponsored Research Agreement CONCERTI.

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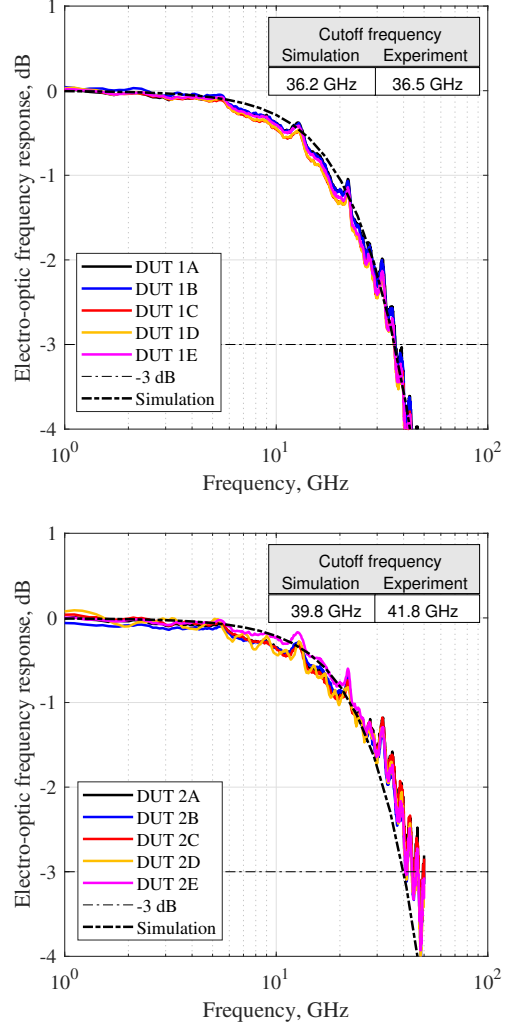


Fig. 2. Simulated and experimental EO frequency response for Device 1 (above) and Device 2 (below).

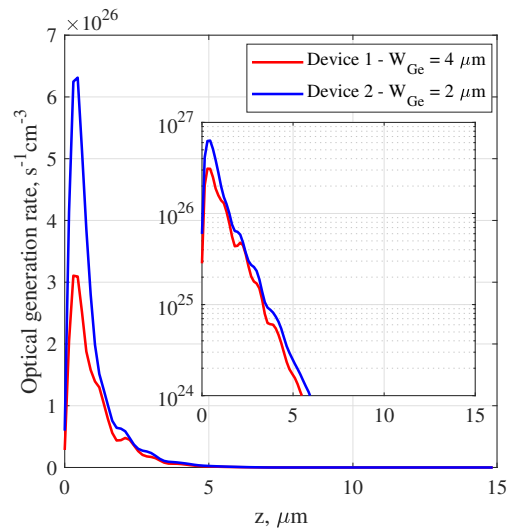


Fig. 3. Optical generation rate in Ge averaged over the WPD cross-section as a function of z .