$Si_{1-x}Ge_x$/Si Heterojunction Internal Photoemission Longwavelength Infrared detector*

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ABSTRACT

Long wavelength $Si_{1-x}Ge_x$/Si heterojunction internal photoemission (t-IIF') infrared detectors have been successfully demonstrated utilizing the growth of degenerately boron doped $Si_{1-x}Ge_x$ layers on Si [1,2]. Recently, $Si_{0.7}Ge_{0.3}$/Si HIP detectors with either a SiGe single layer or a SiGe/Si multi-layer have been demonstrated with cutoff wavelengths out to 23 pm. Near-ideal thermionic emission dark current characteristics were measured and the electrical potential barriers were determined by the Richardson plot. A photoresponse model, similar to the modified Fowler Equation has been developed for the $Si_{1-x}Ge_x$/Si heterojunction internal photoemission (HIP) infrared detector at wavelengths corresponding to photon energies less than the Fermi energy. The optical potential barriers, the corresponding cutoff wavelengths, and the emission coefficients, C_1, for the HIP detectors have been determined from the measured spectral responses using the photoresponse model. Similar optical and thermal potential barriers were obtained. The techniques to further optimize the detector performance will be discussed.

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[1] T. L.. Lin, T. George, E. W. Jones, A. Ksendzov and M. L. Huberman, *Appl. Phys. Lett.*, *60, 380,* (1992).
[2] B-Y. Tsaur, C. K. Chen and S. A. Marine}, *IEEE Electron Device Lett.*, **12**, 293, (1991).

True-Len Lin received his M.S. and Ph.D. degrees in Electrical Engineering from University of California, Los Angeles in 1982 and 1996, respectively. His dissertation work involved Si/Ge molecular beam epitaxy (Si/Ge MBE), and silicon-on-insulator (SOI) technology. He demonstrated the first SiGe/Si heterojunction internal photoemission LWIR detector. While at Jet Propulsion Laboratory, he has been involved in developing novel Si-compatible IR detectors and investigating the radiation effects on the SiGe/Si HIP detectors. He authored and co-authored more than 50 journal publications.