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Dark Current Analysis in Type-II InAs/GaSb Superlattice LWIR Detector with M-structure Barrier

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Abstract

A structure model of long wave infrared detector with M barrier layer is designed. The band structures of InAs/GaSb T2SL and InAs/GaSb/AlSb/GaSb T2SL were calculated using 8-band K · P model. The dark current models with different doping concentrations and layer thicknesses were analyzed by numerical model.

Structure

p-InAs/GaSb contact SLs (0.5 μm)
p-InAs/GaSb/AlSb/GaSb barrier SLs
p-InAs/GaSb absorber SLs
p-InAs/GaSb contact SLs (0.5 μm)
p-GaSb buffer (0.5 μm)
GaSb substrate

Fig. 1 The structure of pπMp LWIR detector.

- Absorber SLs and contact layer SLs are 13 ML (Monolayer) InAs/7 ML GaSb T2SL.
- Barrier layer SLs is 6 ML InAs/3 ML GaSb/5 ML AlSb/ 3 ML GaSb T2SL.
- InSb-like interface layers are added between InAs and GaSb layers to ensure good lattice matching.

Parameters

Table 1. Parameters of material and device used in the simulation

	13/7 MLs InAs/GaSb	6/3/5/3 MLs InAs/GaSb/AlSb/GaSb
Energy band gap at T=77 K [eV]	0.121	0.395
Electron effective Mass [/m_0]	0.022	0.067
Hole effective mass [/m_0]	0.30	0.11
Radiative Recombination rate [m^3/s]	1×10^{-15}	1×10^{-13}
Auger rate [m^6/s]	1×10^{-36}	1×10^{-36}
SRH lifetime [ns]	7	7

Result

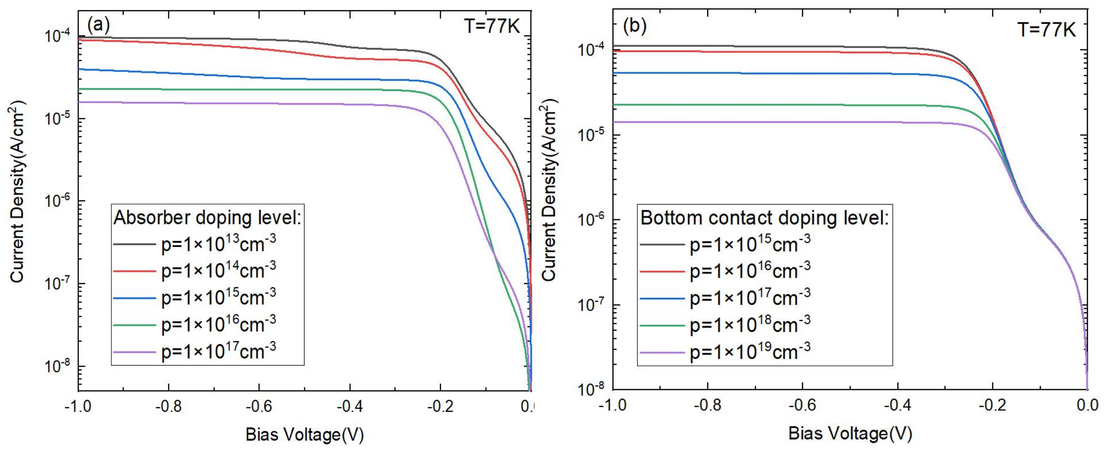

Fig. 2 Dark current characteristics of pπMp LWIR detector at different doping concentrations of 77 K: (a) absorb layer doping concentration, (b) contact layer doping concentration.

- The dark current decreases with doping of absorber layer increasing.
- The dark current decreases with doping of bottom contact layer increasing.

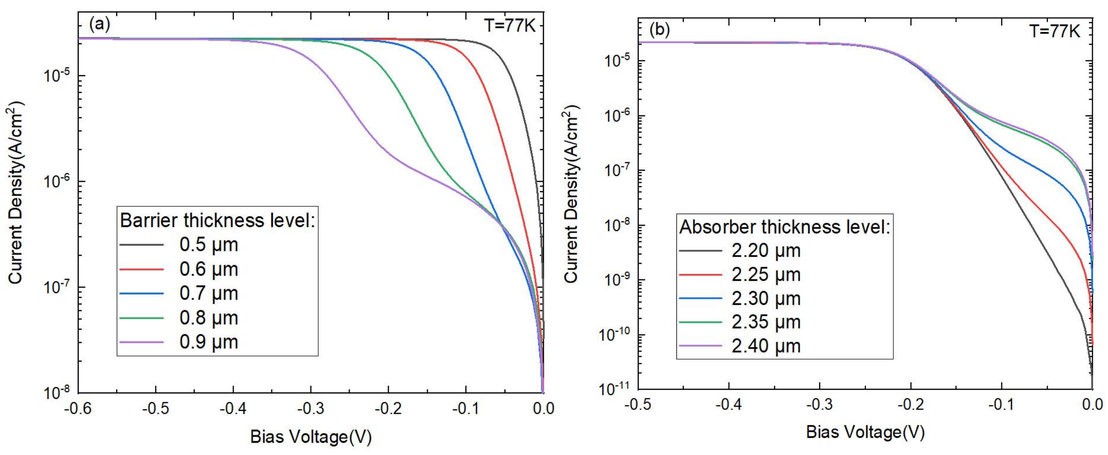

Fig. 3 Dark current characteristics of pπMp LWIR detector at different thickness level of 77 K: (a) barrier thickness level, (b) absorber thickness level.

- The saturation dark current is almost the same, and the saturation voltage increases with the barrier thickness increasing.
- The dark current increases with the thickness of the absorption layer increasing at low bias voltage.

References

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