

Tutorial - THz GaAs/AlGaAs (Fatholouloumi)

Summary

This tutorial is based on the following publication.

[Fatholouloumi2012]

[Terahertz quantum cascade lasers operating up to ~200 K with optimized oscillator strength and improved injection tunneling](#)

S. Fatholouloumi, E. Dupont, C.W.I. Chan, Z.R. Wasilewski, S.R. Laframboise, D. Ban, A. Mátyás, C. Jirauschek, Q. Hu, H. C. Liu
Optics Express 20, 3866 (2012)

This article describes an AlGaAs/GaAs THz quantum cascade laser (QCL) operating at around 2.6 to 3.22 THz. The corresponding input file is called THz_QCL_GaAs_AlGaAs_Fatholouloumi_OptExpress2012_10K-MEDIUM.xml.

Note that we also provide an input file called THz_QCL_GaAs_AlGaAs_Fatholouloumi_OptExpress2012_10K-FAST.xml which is faster but does not produce accurate result. This “**fast**” file is only intended to show the user how to run a “quick” simulation. The results shown here correspond to the “**medium**” file.

Simulation details

We simulate the structure at a temperature of 10 K.

```
<Temperature unit="K"> 10 </Temperature>
```

Device definition

First, the well and barrier materials have to be defined.

```
<Material_Well>
  <name> GaAs </name>                                <!-- GaAs -->
</Material_Well>

<Material_Barrier>
  <name> Al(x)Ga(1-x)As </name>                        <!-- Al(x)Ga(1-x)As -->
  <Alloy_Composition> 0.15 </Alloy_Composition> <!-- x, i.e. Al0.15Ga0.85As -->
</Material_Barrier>
```

Then, alternating layers consisting of barrier and well have to be specified.

```
<Layer>  <!-- #1 -->
  <Barrier_Thickness unit="nm"> 4.1 </Barrier_Thickness>
  < Well_Thickness unit="nm"> 16.0 </ Well_Thickness>
</Layer>

<Layer>  <!-- #2 -->
  <Barrier_Thickness unit="nm"> 4.3 </Barrier_Thickness>
  < Well_Thickness unit="nm"> 8.9 </ Well_Thickness>
</Layer>

<Layer>  <!-- #3 -->
  <Barrier_Thickness unit="nm"> 2.46 </Barrier_Thickness>
  < Well_Thickness unit="nm"> 8.15 </ Well_Thickness>
</Layer>
```

The resulting conduction band edge profile can be found in the file called Band - Edge_vs_position.dat. This file includes the band bending due to the electrostatic potential. At a bias voltage of 54 mV per period, it looks as follows.

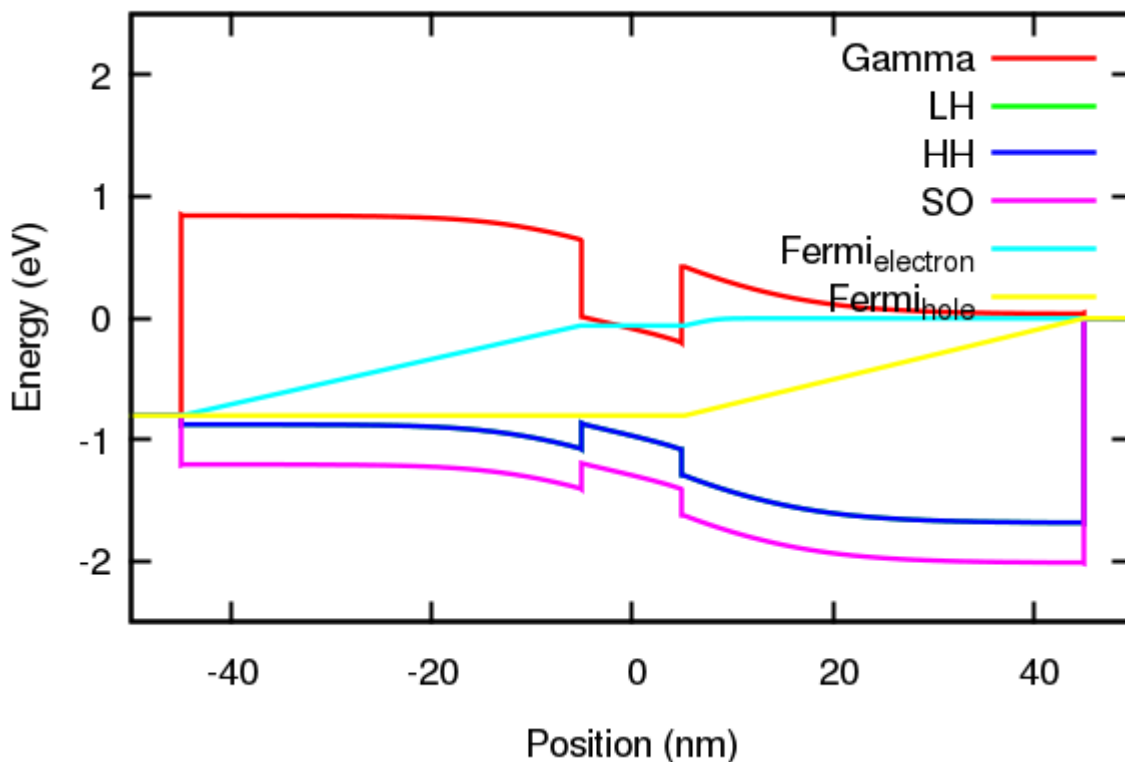


Figure 1: Band edges and quasi-Fermi levels of the **p-i-n** diode under forward bias

Doping

(Discuss the doping here.)

Electric field

(Discuss the potential drop per period here.)

Material parameters

(Discuss chosen masses and band offsets.)

```
<Material_Parameters>
  <Band_Offset          unit="meV"> 120 </Band_Offset>
  <Effective_Mass_Well   unit="m0" > 0 </Effective_Mass_Well>
  <Effective_Mass_Barrier unit="m0" > 0 </Effective_Mass_Barrier>
</Material_Parameters>
```

Gain

(Plot and discuss gain results.)

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