

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.

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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