

How to Make and Study Quantum Wire

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Overview

Features of quantum wire lasers

- 1D quantum confinement
 - Electrons and holes travel in one dimension
- Peaks in the density of states
- Predicted
 - lower threshold current density
 - reduced temperature sensitivity

Several structures

- V-groove
- Etched (wet/dry)
- Ridge
- T-shaped

Graphs

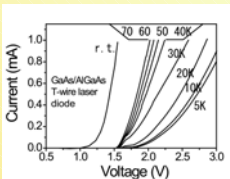


FIGURE 1. Diode current-voltage characteristics of a T-wire laser at various temperatures from 5K to room temperature (r.t.) indicated in the figure.

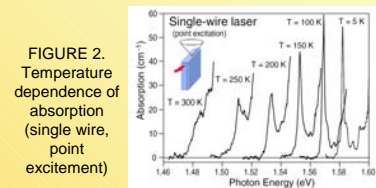


FIGURE 2. Temperature dependence of absorption (single wire, point excitation)

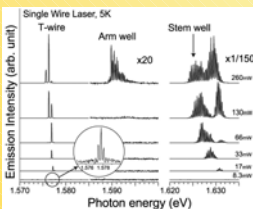
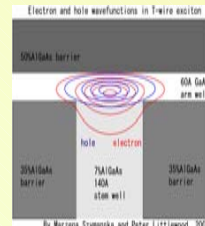


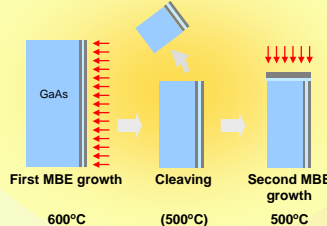
FIGURE 3. Evidence of lasing of the quantum wire

Diagrams

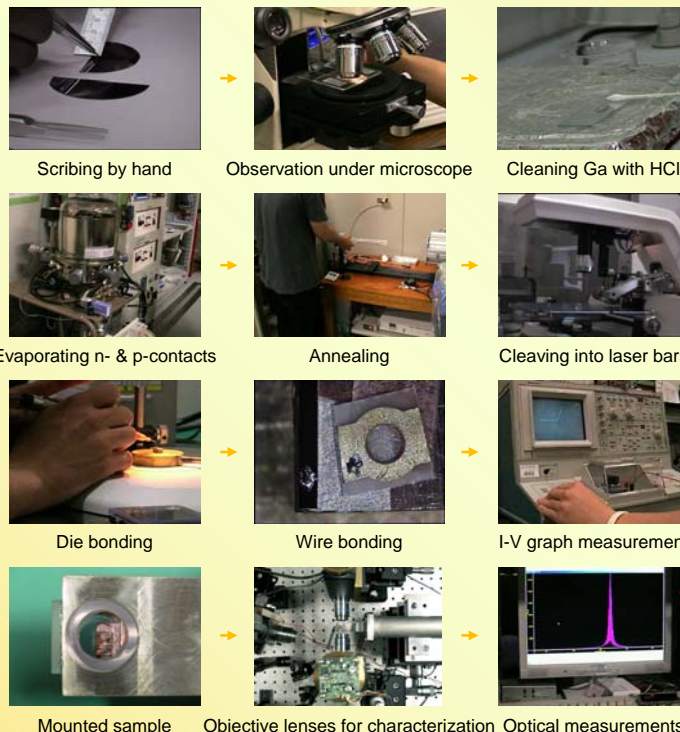
T-shaped quantum wire laser



Cleaved Edge Overgrowth (CEO)



Pictures and Movie Clips



Fabrication

T-shaped wire lasers are created by *cleaved edge overgrowth* (CEO) with Molecular Beam Epitaxy (MBE).

A thin film (stem well) is grown first on a GaAs wafer. The wafer is then scribed and thinned by polishing from the reverse side.

The pieces of thinned wafer are again placed into an MBE machine, and cleaved *in situ*.

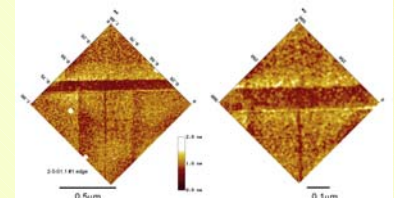
Additional layers (arm well) are grown on the side, producing a T-shaped intersection of two GaAs quantum wells. Along the line of the intersection of the two quantum well planes, quantum confinement is relaxed, and a 1D channel for electrons and holes is created.

Each piece after the growth is processed to form n-type and p-type electrodes by cleaning, etching, metal evaporation, and annealing.

The processed piece is then scribed and cleaved into laser bars that are 0.5 mm wide. The laser bars are glued onto copper blocks and wired by thin gold and indium solder.

The laser samples are characterized by microscope, and IV curve tracer, and then analyzed by spectroscopy at low temperatures under current injection and optical pumping.

AFM pictures of T-shaped quantum wire laser



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