9th MaMaSELF Status Meeting 2017

Education and Culture DG

ERASMUS MUNDUS

Contribution ID: **17** Type: **not specified**

Characterization of doped GaAs-AlGaAs core-multishell nanowire lasers

Thursday 18 May 2017 14:15 (30 minutes)

Electrically driven III –V semiconductor nanowires (NWs) are wildly considered to be a potential frontier in small and coherent light sources for photonic integrated circuits. One of most essential characters of semiconductor nanowires is that its active mediums of lasing are surrounding by dielectric shells which forming an innate optical cavity and waveguide due to 1-D geometry. However, for fabrication of electrically driven nanowires laser, there are 4 key factors to be utilized, high carrier density, low contacting resistance, homogeneous etching and carrier confinement in active mediums, respectively. Hence, we are going to develop methods to resolve these 4 topics and achieve electrically driven nanowire lasers.

In this work, the GaAs nanowires with multi-shells structure are grown in silicon (111) substrate using both vapor-liquid-solid and selective area methods by Molecular beam epitaxy (MBE). Then for n-type GaAs nanowires, GaAs nanowires are heavily doped with Si which incorporating on Ga sites and acting as a donor during MBE growth. Similarly, heavily Carbon doped GaAs nanowires function as a p-type semiconductor due to Carbon occupying arsenic sites as an acceptor.

In the first part, the doping concentration is determined by Photoluminescence spectroscopy (PL) and nanowires field effect transistor (NWs-FET). For Photoluminescence spectroscopy (PL), the shape of spectrum is proportional to the occupied states in conduction band (CB) in degenerated semiconductor and the carrier density is deduced from the edge of conduction band (CB), Fermi level (EF) and lattice temperature by fitting Photoluminescence spectra with density of state function. For nanowires field effect transistor (NWs-FET), the top-gate geometry and 4 probes measurement are adopted in measuring carrier mobility and conductivity in nanowires for solving carrier concentration.

In second part, in order for Ohmic contact to n-type GaAs, there are several papers reporting different metallization including Ge/Ni/Au, Co/Ge or AuGe/Ni/Au. Here we perform the good Pd/Ge/Au ohmic contact on n-type GaAs nanowires.

In third part, the simplest structure for electrically driven nanowire laser is p-i-n core-shell structure (p-type core, intrinsic shell and n-type shell respectively) and due to electrically driven purpose, there is a metallic connection on core and shell individually. Thus, it is necessary for us to develop homogeneous etching to metallic contacting on core.

In last part, we will simulate the propagation mode of laser and optimize the thickness of active medium within core-multi-shells structure in nanowires.

Summary

In summary, the study of Photoluminescence spectra show that the highest carrier concentration in n-type GaAs nanowires is n=2.1×10ˆ18 cmˆ-3. Second, the contact resistance on n-type GaAs nanowires is around 10ˆ9 Ω before annealing and 10ˆ3 Ω after annealing. Third, the homogeneous etching is performed by citric acid (CA) and H2O2 solution. And the etching rate of CA/H2O2 solution is 0.2 Ås on GaAs multi-shells nanowire structure.

Author: Mr WANG, WenChing (MaMaSELF/TUM)

Presenter: Mr WANG, WenChing (MaMaSELF/TUM)

Session Classification: Student Session