Ming Hsieh Department of Electrical Engineering

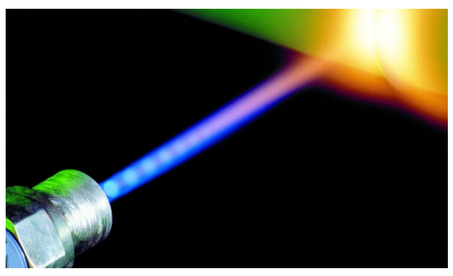
USC Viterbi School of Engineering

Enhanced Photoluminescence of GaAs Nanowires by Remote Oxygen Plasma Treatment

Dustin Tso[1], Nirakar Poudel[1], Shermin Arab[2], Maoqing Yao[2], Chongwu Zhou[2], P. Daniel Dapkus[1,2], and Stephen B. Cronin[1,2]

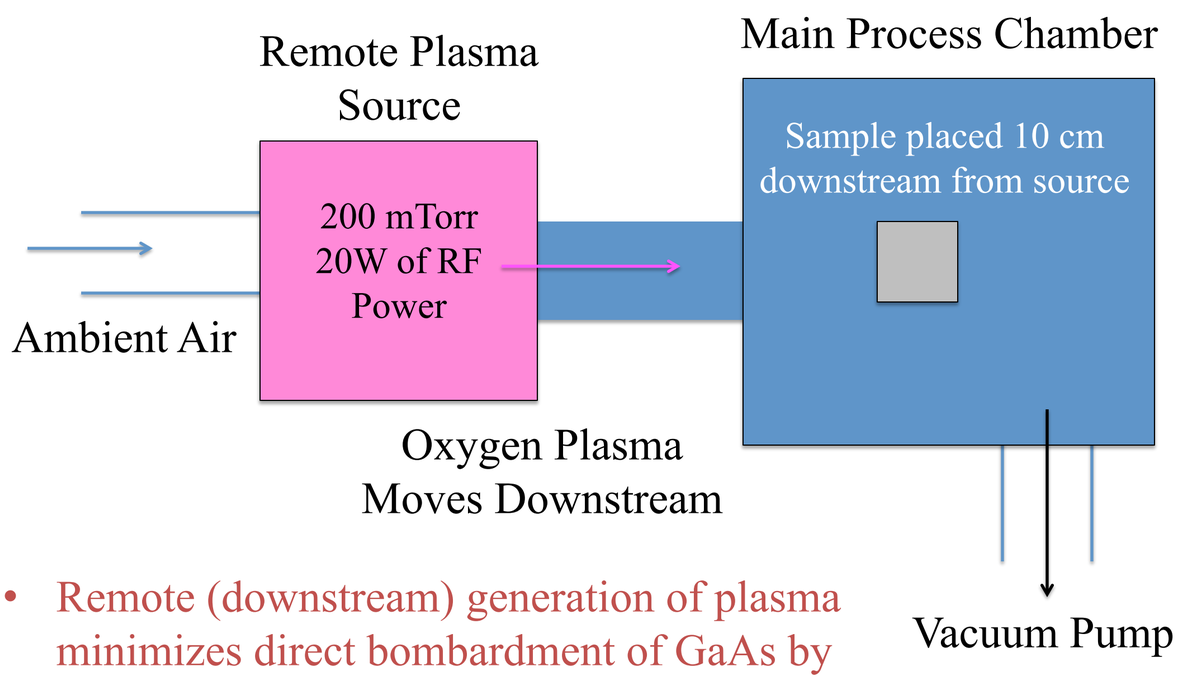
Motivation and Introduction

- GaAs nanowires are an excellent candidate for high efficiency solar cells, nanolasers, LED applications, and integrated circuits



- High surface state densities and high surface recombination velocities limit optoelectronic performance
- We present a novel method for GaAs surface passivation utilizing a remote oxygen plasma treatment

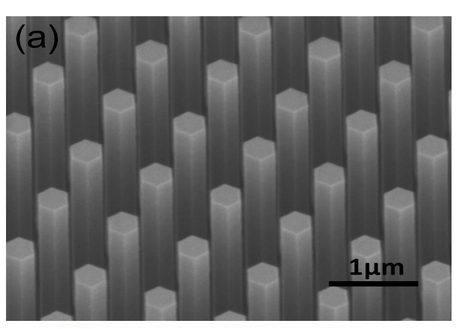
Remote Oxygen Plasma

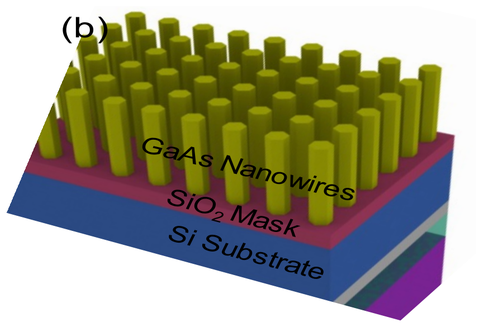


- Remote (downstream) generation of plasma minimizes direct bombardment of GaAs by ionic species
- Ensures passivation of surface states is primarily driven by the chemical reactivity of the oxygen radicals

Sample Preparation

- GaAs nanowires are grown on silicon substrates using MOCVD with selective area growth
- Growth on silicon enables PL measurements to be taken without contribution from underlying substrate

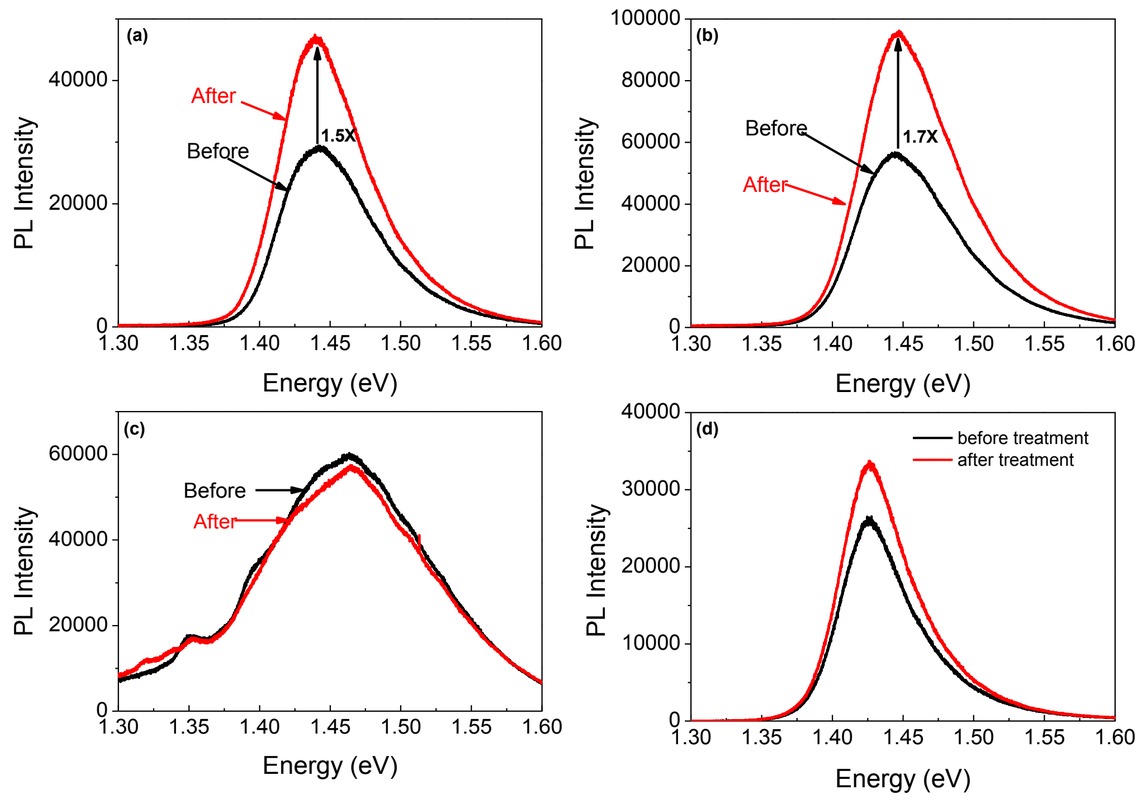




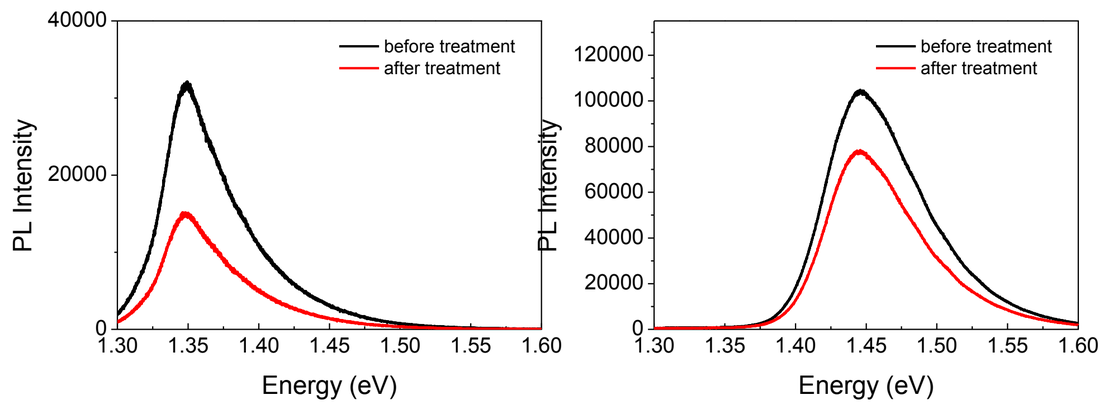
- Samples with different carrier concentrations are prepared by varying the partial pressure of disilane from 0.01 sccm to 1 sccm in order to increase the amount of Si dopants during different growth runs

Measurements and Results

- Photoluminescence Spectroscopy (PL) is used to measure samples before and after the remote oxygen plasma treatment



- Above are PL spectra taken before and after remote oxygen plasma treatment for silicon doping conditions of (a) 0.01 sccm (b) 0.1 sccm (c) 1 sccm and (d) planar GaAs



- Above are control experiments we ran. On the left is the PL spectra of planar InP wafer before and after remote oxygen plasma treatment
- On the right is the PL spectra a 0.2 sccm doped GaAs nanowire before and after plasma ashing

Conclusion and Next Steps

- We believe that the O-radicals from this remote oxygen plasma are binding to charged surface states, which passivates these surface states and results in improved PL intensity
- Enhancement is more pronounced in lightly doped nanowires, which have fewer impurities, making them more susceptible to surface recombination
- Heavily doped nanowires have negligible changes in PL intensity since the high density of impurities causes substantial non-radiative recombination in bulk material

Next Steps

- Low temperature PL measurements
- Expose samples to plasma for different times (we used 2 minutes for every measurement)