External electric field modulated photoluminescence of graphene/GeSi QDs hybrid structure

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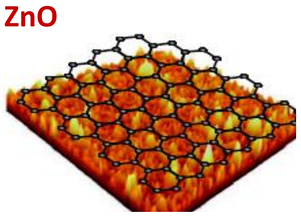
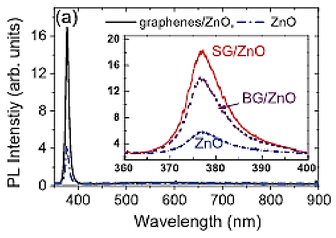
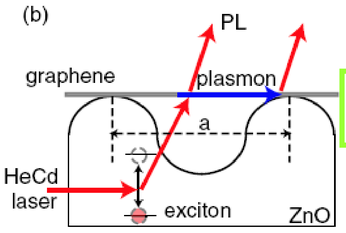
Introduction

Hybrid structure of graphene on traditional semiconductors

◆ ZnO







$$\omega(q) = \left[\frac{n_e e^2}{\epsilon_0(1+\epsilon_b)m^*}q + \frac{3}{4}v_F^2 q^2\right]^{1/2}$$

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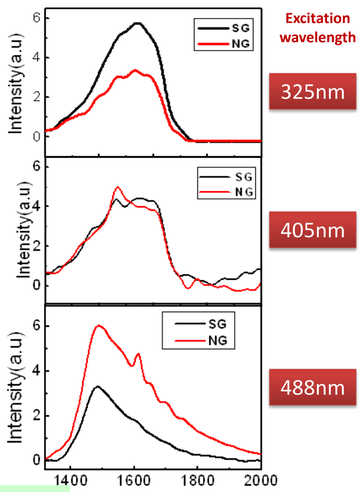
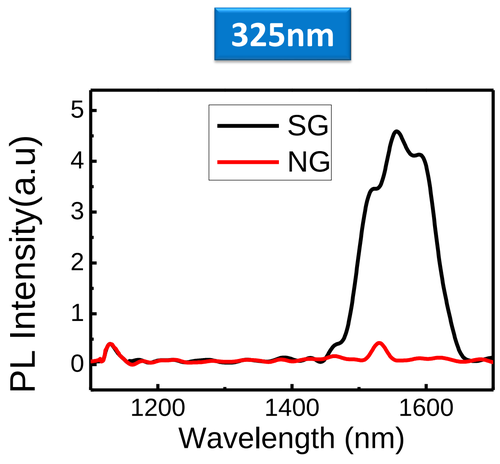
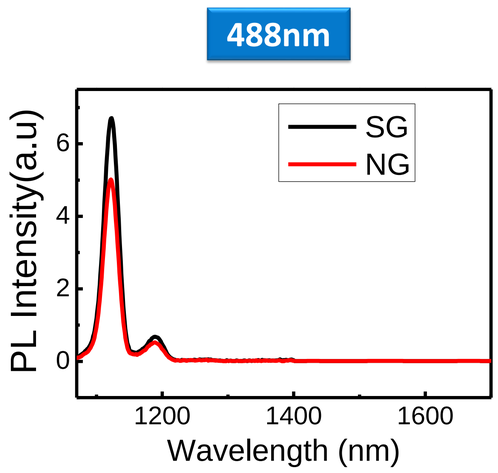
◆ GeSi QDs



photoluminescence



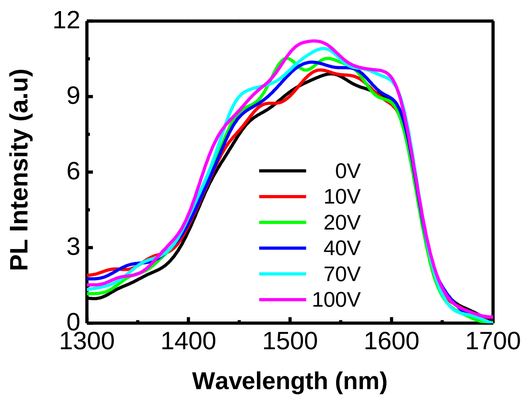
◆a strong PL signal from the surface QDs at about 1556nm for the SG region



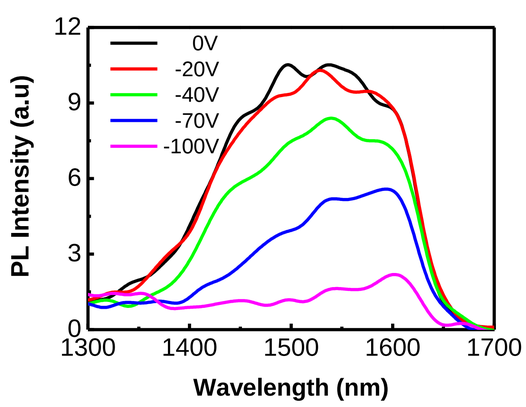
◆only the PL signals from Si substrates for both the SG and the NG region

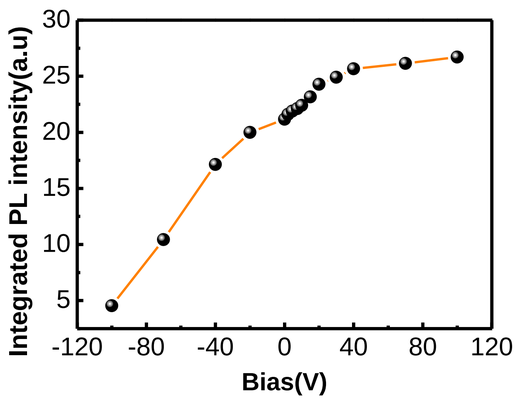
External electronic field modulated PL

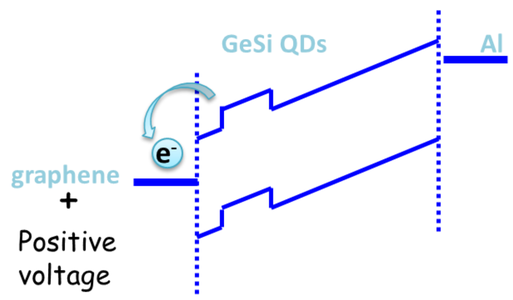
positive bias applied on the Al electrode



negative bias applied on the Al electrode

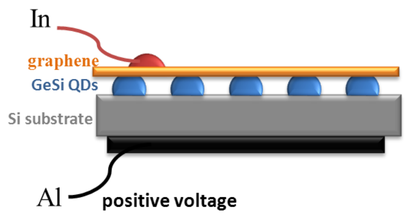






Experiment

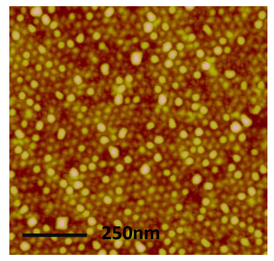
Sample structure



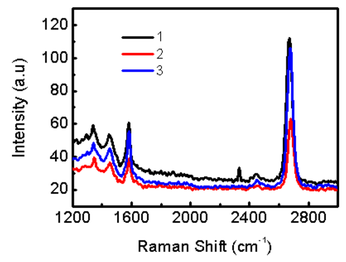
GeSi QDs
Size: about 60nm
High density, random growth

Measurement

AFM

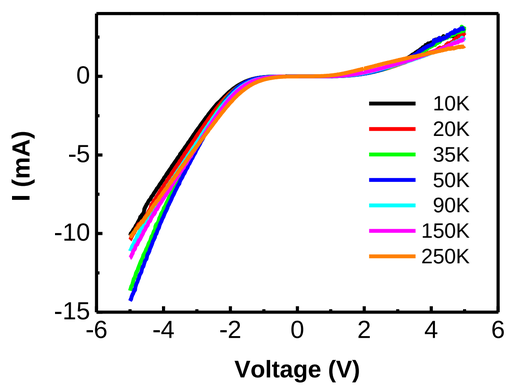


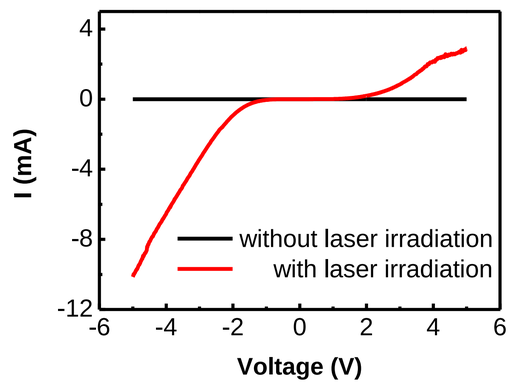
Raman



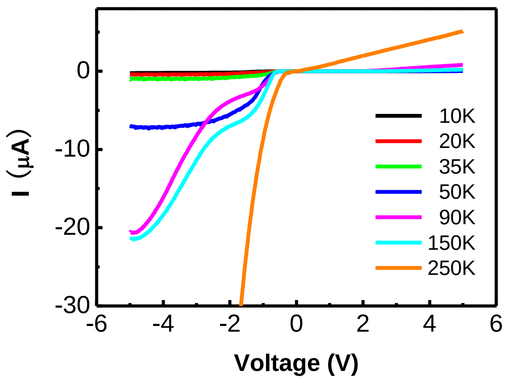
I-V curve

With Laser Irradiation





Without Laser Irradiation



The back electrode: thermal evaporation of 300nm aluminum on the back of the silicon wafer (as **P**)
The positive electrode: In as a point electrode ($4mm^2$) (as **N**)

Discussion

◆ Red shift of peak take place from about 1500nm (0.83eV) to about 1600nm (0.78eV)

◆ The PL enhancement began to get saturated at the bias of 40V

◆ The tunnel breakdown would appear at the bias of 150V

◆ The changing carrier density n caused by the external electronic field is about $10^{10}cm^{-2}$

Summary

- The PL results indicate the PL intensity can be modulated by electric field from enhancement to quenching
- The electron would transfer from the GeSi QDS to the graphene sheet which largely decrease the PL intensity