Chapter 8 Conclusions and Future works

8-1. Conclusions

Three-dimensional dispersed Si nanocrystals (NCs) were dispersed within the nanopores of mesoporous silica films by high-density plasma (HDP), low-density plasma or implantation. Surface states of the resulting Si NCs/silica arrays initiate blue-white photoluminescence (PL). ICP makes reactive species highly mobile and enables deposited NCs bonded with pore-wall well, therefore, efficiently constructing photoemission arrays. The mean density of HDP-synthesized semiconducting NCs is as high as $1x10^{18}/cm^3$. Accordingly, blue-PL of arrays obtained with HDP is 4-7 times stronger than those obtained with other methods.

Besides, the mean density of Pulse ICPCVD-based semiconducting NCs is as high as $8x10^{18}/cm^3$. Accordingly, blue-PL of arrays obtained with Pulse ICP is 2 times stronger than those obtained with HDP.

An UV to blue light photodetector can also be constructed by 3-D Si NCs/silica arrays with ITO contact.

8-2. Future works

Si-based optoelectronic materials are compatible with standard silicon ULSI technology and cause rather low cost. In the future, Si-based optoelectronic devices will have many important applications, such as Si-based light emitter or photodetectors. In my research, blue-PL of Si NCs/silica arrays exhibits quantum-efficiency of 1%, near the reported value for green-to-red light emission from quantum-confined Si NCs. In the future, electroluminescence of Si NCs/silica arrays will be devoted. Besides, we can also dope Erbium into mesoporous silica films to emit long wavelength light for optical communication.

As for photodetectors, samples using n-type Si substrate will be fabricated and measured to demonstrate that our photodetectors are electron-transport-dominated. Then, samples with smaller pore size will also be fabricated:

(1) To fabricate more uniform QDs in size for higher carrier transport efficient.

(2) To improve the efficient of UV detection.