Effect of argon atmosphere on photoluminescence properties of SiO_xC_y thin films deposited by O-Cat CVD technique using TEOS precursor

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Introduction

- Silicon based materials attract so much attention due to its cost effectiveness.
- It dominates the electronic industry, however the development of optoelectronic devices represents technological challenges due to its band gap structure [1].
- This problem can be overcome with the principle of uncertainty of Heisenberg.

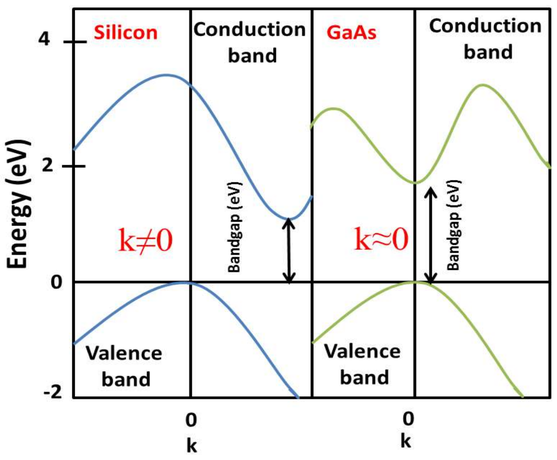

Fig.1. Band structure of GaAs and Si material.

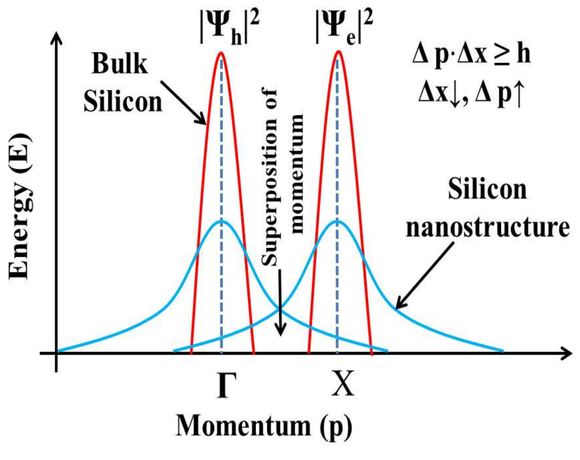

Fig.2. Function of the electron and holes as wave particle for the Si and Si nc.

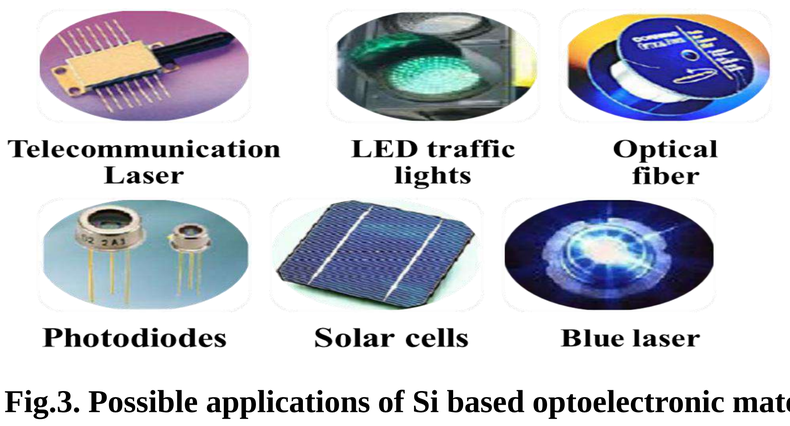

Fig.3. Possible applications of Si based optoelectronic material.

Experimental Procedure

Variable parameter
Argon flow

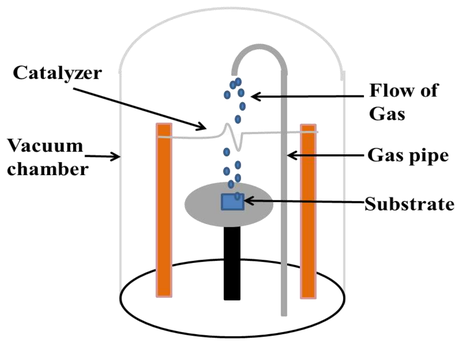

Fig.4. Schematic diagram of O-Cat CVD Technique

Deposition Conditions:

Precursor: TEOS + Argon gas
Filament: Tungsten (W) wire
Substrate: Si p-type

Constant Parameters:

Substrate temp.: 200ºC
Working pressure: 0.30 torr
Filament temp.: 1800 ºC

Results and discussion

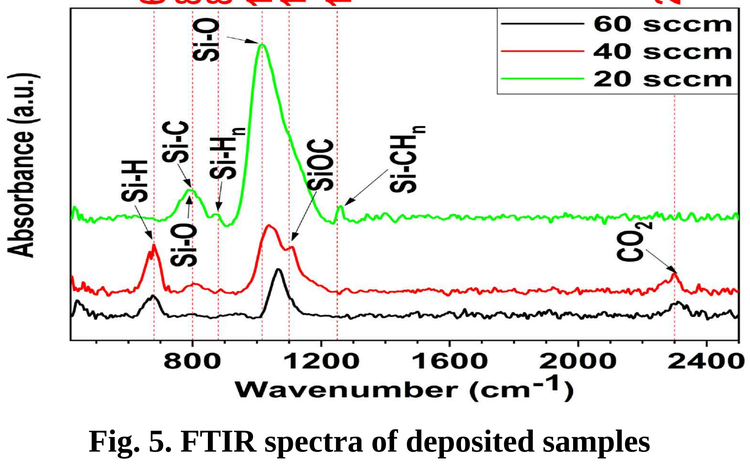

Fig. 5. FTIR spectra of deposited samples

- FTIR spectra showed a Si-O-Si absorption band at 1016 cm^{-1}, which was shifted from its stoichiometry value (1080 cm^{-1}).
- This shift from the stoichiometry value of Si-O-Si, represents the deficiency of oxygen in Si-O-Si bonding, which may generate a higher probability of having one or more Si/C neighboring atoms [2].
- This compositional and stoichiometrical changes in oxide layer (Si-O-Si) may allow to control the intensity of the luminescence and its spectral composition [2].

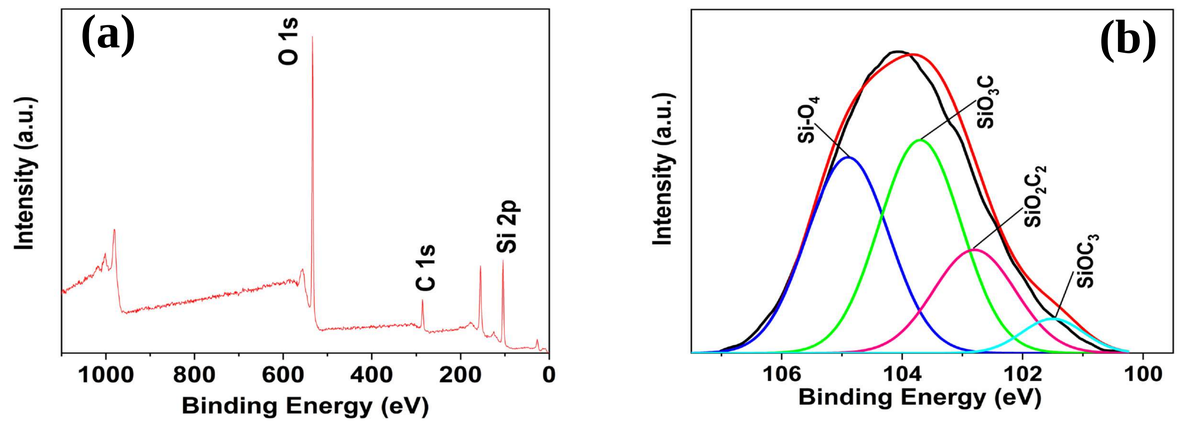

Fig.6. XPS spectra of a) SiO_xC_y, b) Si 2p for deposited sample with 20 sccm Ar flow.

- Characterizations of FTIR and XPS have confirmed the presence of expected chemical species i.e. Si, O, and C elements in the deposited thin films and it confirmed the existence of SiO_xC_y.

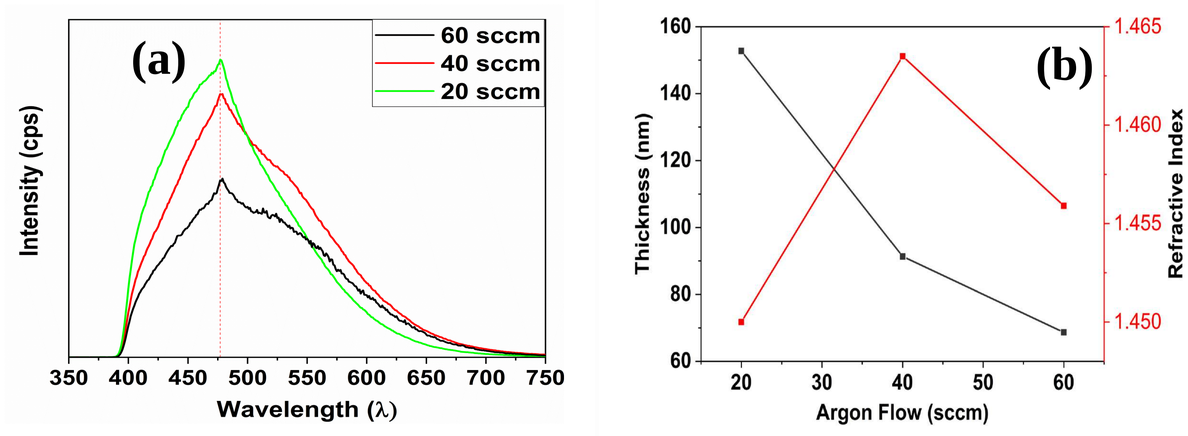

Fig.7. a) PL spectra and b) Refractive index and thickness by ellipsometry of deposited samples at various flow of argon gas.

- Broad and intense PL spectra observed which is directly proportional to the thickness of thin film.

Possible PL mechanism

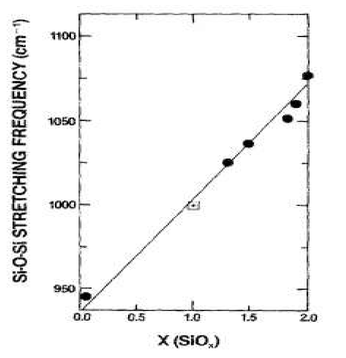

Fig.8. Si-O-Si stretching vibration as a function of oxygen.

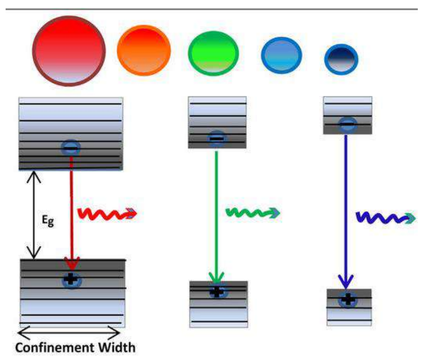

Fig. 9. Illustration of quantum confinement effect.

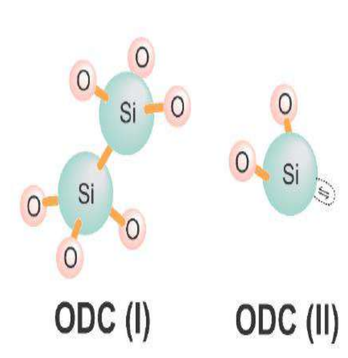

Fig. 10. Structure model of oxygen deficiencies

Conclusions

- The formation of thin film SiO_xC_y with intense luminescence were observed by using silicon based organometallic precursor i.e. Tetra-ethyl orthosilicate [TEOS].
- FTIR and XPS characterizations confirmed the presence of Si, O and C elements in the film and the analyses of PL spectra showed high intensity with low flow of argon gas.
- The origin of PL emission can be due to different defect mechanisms or quantum confinement effect [2, 3], which can be clarify by further analyses.

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