

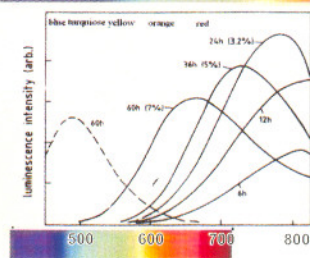
ELECTROLUMINESCENCE OF SILICON NANOPARTICLES IN LED STRUCTURES

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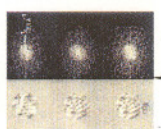


- Motivation**
- Light emitting diode in the visible spectrum based on silicon nanocrystals (Si-NC)
 - Light emitting devices for all silicon optoelectronics.

Combustion of Silane (SiH₄)

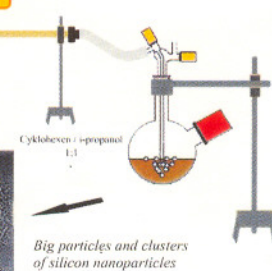


Silicon nanocrystals - used as the active layer in a number of optical and optoelectronic devices



The size of Si-NC is reduced by etching in HF/cyclohexane-propanol solution [1]

SILANE → CLUSTERS, PARTICLES, POWDERS



Big particles and clusters of silicon nanoparticles

Strong photoluminescence is activated

Reducing particle size

Particles not emitting light

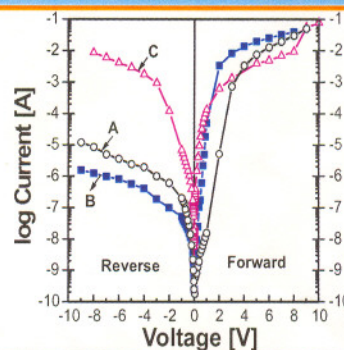
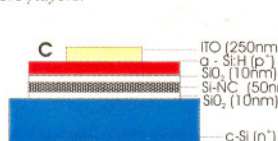
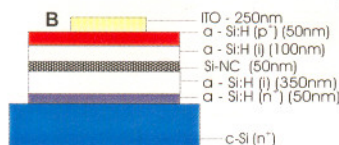
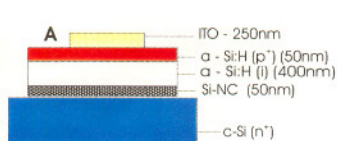
Electrical measurements

Different structures of LEDs were prepared on monocrystalline Si (c-Si)

Type A, B: Si-NC deposited by dropping of colloidal suspension on c-Si and isolated by a-Si:H(i) upper layer (A) or embedded between two a-Si:H (i) layers (B)

The I-V characteristics of p-i-n diodes with Si-NC for A), B) and C) types measured at RT and in dark

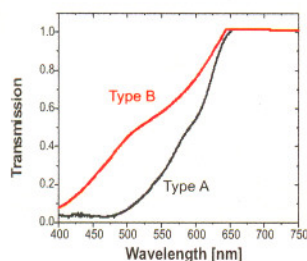
Type C: Si-NC deposited electrochemically from colloidal suspension and isolated between two SiO₂ layers.



Electroluminescence

Experimental set-up for EL imaging and spectroscopy:

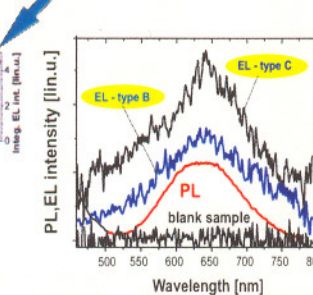
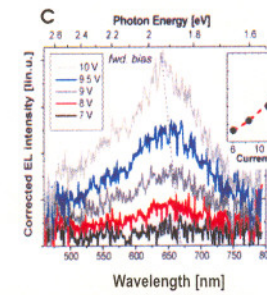
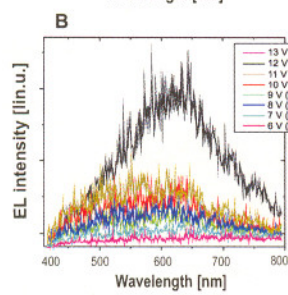
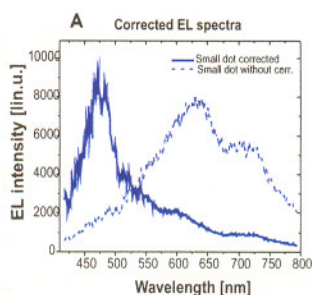
- Micro-imaging optical system
- Imaging spectrograph Jobin-Yvon Triax 320
- Intensified CCD camera PI-MAX Princeton Inst.



Sample Type C, fwd bias 8V EL emission is typically nonuniform, but visible by naked eye.

Integrated EL intensity grows with square of current.

This may indicate bimolecular recombination mechanism, i.e. direct injection of both electrons and holes into the Si-NCs, according to Kanemitsu [2]



Conclusions

- The light emitting diode structure based on silicon nanocrystals (Si-NC) formed by the Silane combustion was demonstrated.
- The EL under forward bias above 8V was visible with a naked eye, indicating efficient carrier injection into nanocrystals.
- The integrated EL grows with square of current, this indicates bimolecular recombination mechanism.

Acknowledgement

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References

- [1] A. Fojtík and A. Henglein, Chem. Phys. Letters 221 (1994) 363-367
- [2] Y. Kanemitsu, Physics Reports 263 (1995) 1