Dopants Dependent Microplasma Induced Surface Chemistries on P- and N-Doped Si-ncs

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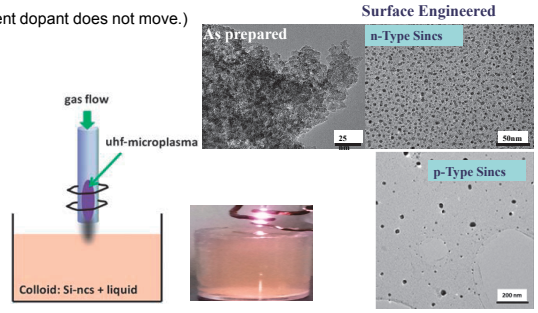
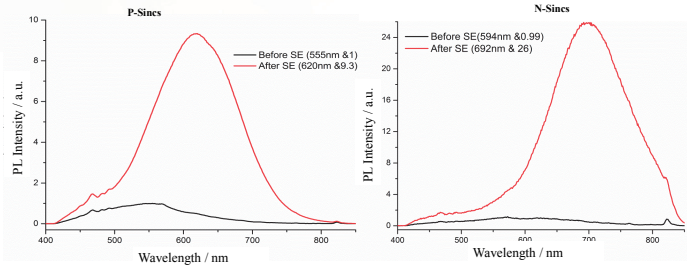
Motivation

- Silicon nanocrystals (Si-ncs) carrier multiplications, abundance and non-toxicity are important for a next generation low cost and high efficiency PV fabrications.
- The doping of Si-ncs presents a unique scenario which in principle is enabling control of the energy band gap and the Fermi energy to yield both n- and p-doped nanocrystals.
- The position of the work function is playing the important role for band alignment in solar cells, which results in photocurrent collection efficiency with improved device performance.

Surfactant free surface engineering of doped Si-ncs

- p and n doped Si-ncs prepared by electrochemical etching (without thermal treatment dopant does not move.)
- RF microplasma (450MHz, 45 W power is Ar used)
- 3 mg of doped Si-ncs is suspended in ethanol. (3.5 ml) (processed for 30 min)
- The distance between the capillary tip and colloids surface is 1 mm.

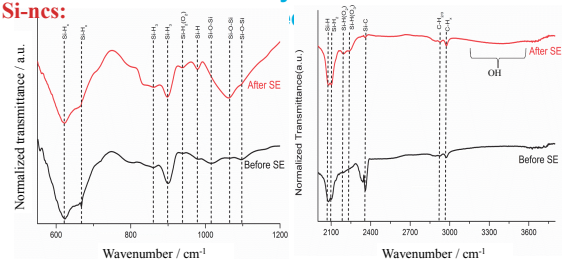




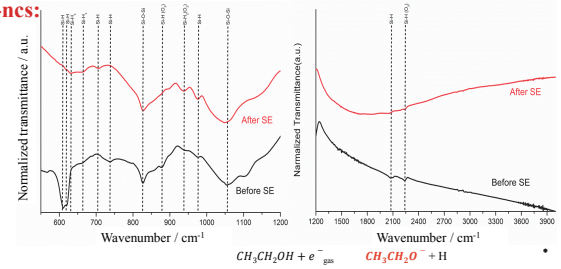
- PL intensity of p-Si-ncs increased by 9 times and 65 nm red shift was observed.
- PL intensity of n-Si-ncs increased by 26 times and 100 nm red shift was observed.

FTIR and Chemistry at Si-ncs Surface

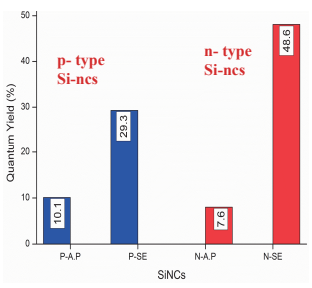
p- type Si-ncs:

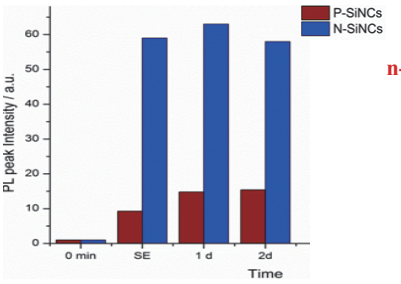


n-type Si-ncs:

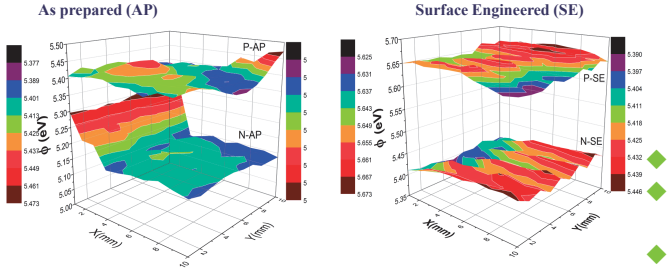


Absolute quantum yield (QY) and stability of doped Si-ncs

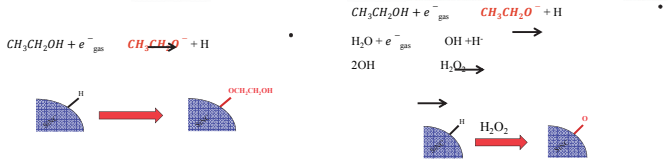




Work Function ϕ of Si ncs



Used to understanding the relative position of the Fermi level



- e- reacting with ethanol removes the H and produces the $CH_3CH_2O^-$.
- p-Si-ncs are e-deficient and then surface radicals can easily react and replace the Si-H termination with Si-O-CH_2-CH_3.
- $CH_3CH_2O^-$ may not be reacting with surface of n-Si-ncs then as a result H_2O_2 is produced. (absence of OH^- absorption peak in FTIR)

Conclusions

- Efficient surfactant free microplasma surface engineering of doped Si-ncs.
- Enhanced PL quantum yield and stability in water for n-Si-ncs.
- Position of work function (Fermi level) can be tuned by surface engineering and doping.

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