Silicon-based materials continue to show outstanding promise as a base for renewable tandem photovoltaic solar cell due to its abundance and nontoxicity. Here, silicon quantum dots (Si QDs) which are embedded in a silicide dielectric matrix offer attractive prospects as components in third-generation photovoltaic devices (Benami A, Monroy B M, Ortiz A et al, 2007). Due to Si QD’s tunable band gap, which uses a wide range of the solar spectrum, higher efficiencies are achieved.. Previous theoretical and experimental results confirmed that the band gap can be fine-tuned by tailoring the size of the QDs and the existing chemical environment (Conibee G, Martin G, Corkish R et al., 2006). Optimizing the distance (separation) and barrier height between Si QDs could result in both a large band gap and sufficient carrier mobility.Photoluminescence and high resolution transmission electron microscopy have been used to demonstrate the correlation between the optical band gap and discrete sizes of Si QDs according to quantum confinement model (Song D Y, Cho E C, Conibeer G etc.).

Previous research has mainly focused on Si QDs embedded in silicon oxide or silicon nitride matrix, but not those embedded in silicon carbide. However, silicon carbide (SiC) is reported to have lower barrier height (~2.5 eV) compared to SiO2 (~9 eV) and Si3N4 (~5.3 eV). In such a case, the transport possibility of carriers among adjacent Si QDs can be increased due to the lower tunneling barriers for electrons and holes. Thus it may be a good candidate matrix for photovoltaic solar cells. From this point of view, Si-rich Si*x*C thin films can be used as the precursors to produce higher density of Si QDs with broader bands and higher mobility for all silicon tandem solar cell applications. D. Y. Song et al. and K. Ostrikov et al. investigated Raman scattering and Fourier transform infrared absorption of Si QDs in α-SiC prepared by plasma-enhanced chemical vapor deposition (PECVD) without post-annealing. The formation mechanism of these nano-objects, however, remains controversy, and Si clusters may be grown in the special reactive atmosphere depending on plasma conditions. So it is still a great challenge to control the size and the density of Si QDs embedded in α-SiC synthesized by PECVD. Therefore, much more works are required to produce high-quality Si QDs, and to experimentally study the quantum confinement effect (QCE) of Si QDs.

In the present letter, we reported on the preparation of Si QDs in α-SiC dielectric matrix through high-temperature annealing of non-stoichiometry SixC (*x*>1) thin films. Photoluminescence (PL) measurement indicated obvious multi-band characteristics, and the optical band gap could be tuned from 2.36 to 3.47 eV by varying the atom ratio of silicon and carbon (RSi/C). This would be related with the size distribution of Si QDs as a result of quantum confinement effect, which will be discussed in hereinafter in details.