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Optical and electrical properties of amorphous silicon quantum dots for device applications

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Amorphous silicon quantum dots (a-Si QDs) were grown in a silicon nitride film by plasma enhanced chemical vapor deposition. Transmission electron micrographs clearly demonstrated that a-Si QDs were formed in the silicon nitride. Photoluminescence and optical absorption energy measurements of a-Si QDs with various sizes revealed that tuning of the photoluminescence emission from 2.0 to 2.76 eV is possible by controlling the size of the a-Si QD. Red, green, blue, and white photoluminescence(PL) were observed from the a-Si QD structures by controlling the dot size. An orange light-emitting diode (LED) was fabricated using a-Si QDs with a mean size of 2.0 nm. The turn-on voltage of 5 V and an external quantum efficiency of $2 \times 10^{-3} \%$ were demonstrated. In addition, C-V curves of a-Si QDs were measured and this result will also be discussed for device applications.