istics of the spectral sensitivity of each layer when the light intensity was 4 SUN and the irradiation and recovery times are, respectively, 205 and 517h, with the temperature being maintained at 50°C. It can be seen that the levels of degradation for the middle and top layers are quite large compared to the degradation level of the bottom layer which is also the same as far as their recovery processes are concerned.

Fig. 3 shows the degradation and recovery characteristics of J_{sc} for each layer under the same conditions as those for obtaining the results illustrated in Fig. 2. In this case the value of J_{sc} is normalised to an initial value. The degradation of J_{sc} for the middle layer is 12% while it is almost the same (6%) for both the top and bottom layers. The recovery of J_{sc} for the middle layer is 6.5% followed by a value of 4% for each of the other two layers. From Figs. 1 and 3 it is evident that the nature of the curves depicting the degradation and subsequent recovery processes for both η and J_{sc} follow almost the same pattern: a rapid initial decrease followed by much slower advances in the case of degradation.

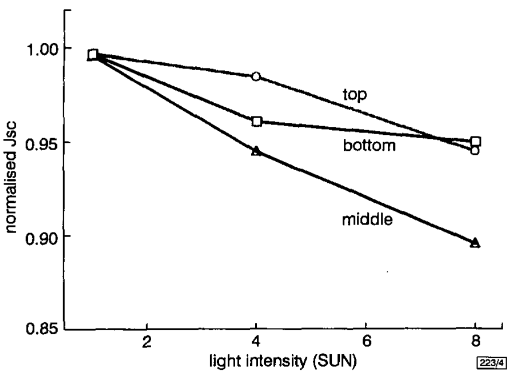

Fig. 4 *Optical intensity dependence of degradation characteristic of current density after 20h at 70°C*

A higher level of degradation occurs in the bottom and middle layers compared to that in the light-facing top layer. Fig. 4 shows the degradation characteristic of J_{sc} for each layer under the fast test process with light intensities of 1, 4 and 8 SUN, the exposure time being 23h. The decrease in the value of J_{sc} is minimum for the top and highest for the middle layer. For the bottom layer, J_{sc} decreases to a certain value until the light intensity becomes 4 SUN. But after that it becomes almost constant even when the intensity is increased to 8 SUN. The level of degradation of η corresponds to that for the J_{sc} of each layer. From Fig. 4 it is also evident that the deterioration does not depend on the light intensity after a certain value.

Conclusion: We have evaluated the degradation and subsequent recovery characteristics of each layer of a three-layer stacked a-Si solar cell by comparing the η and spectral sensitivity (and hence J_{sc}). The degradation in spectral sensitivity and recovery for each layer have been found to show a corresponding change in η and a strong correlation. It also establishes a normal phase barrier for the light intensity. As far as the degradation is concerned, its value is highest for the middle layer, followed by the top and bottom layers. It is evident that the degradation pattern for the bottom layer should be chosen as standard as far as the evaluation of the overall η is concerned. This is because the smallest absolute value of spectral sensitivity is obtained for the bottom layer. Moreover, solar cell degradation of the light-facing top layer occurs quickly and the degradation at this point is seen to reach a saturation level.

29 September 1999
Electronics Letters Online No: 19991351
DOI: 10.1049/el:19991351

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Formation of Si nanoclusters in amorphous silicon thin films by excimer laser annealing

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It is shown that an Si nanocluster is formed in an amorphous silicon (a-Si) thin film following irradiation using a pulsed KrF excimer laser. The photoluminescence spectrum of the irradiated 70nm thick a-Si film at a power density of 180mJ/cm^2 at one shot shows two luminescence bands centred at ~1.31 and 1.76eV. The peak emission wavelength depends on the silicon nanocluster size, which is ~3–4nm. A mechanism for the formation of Si nanoclusters is also proposed.

The formation of nano-structural Si has attracted increasing interest since the discovery of an efficient light emission from porous silicon. Quantum confinement has been suggested as the cause of observed luminescence and enhanced nonlinear optical properties [1, 2]. Various methods, including pulsed-laser ablation (PLD) [3], laser-induced gas phase reaction [4], size-exclusion methods [5], ion implantation [6] and spark processing [7], have been used to prepare Si nanoclusters (nc-Si). In this Letter, we investigate the formation of Si nanoclusters in an amorphous silicon (a-Si) thin film following irradiation using a pulsed KrF excimer laser. The preparation parameters such as the a-Si thickness are studied to understand their effect on the properties of Si nanoclusters, such as their size and size distribution. A mechanism for the formation of Si nanoclusters is also proposed.

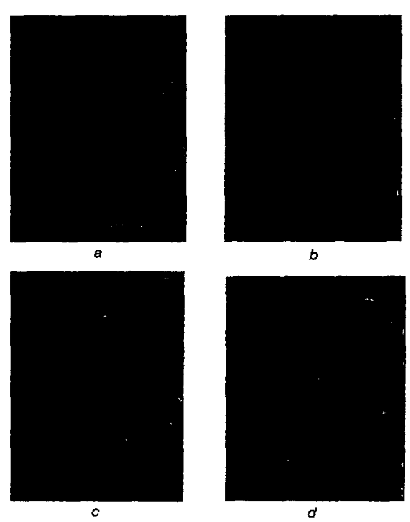

Fig. 1 *SEM pictures showing surface morphologies of the 10, 30, 50 and 70nm thick a-Si layers irradiated by KrF laser with power intensity of 180mJ/cm^2 at one shot, respectively*

a 10nm
b 30nm
c 50nm
d 70nm

Amorphous Si was deposited by plasma enhanced chemical vapour deposition (PECVD) at 250°C onto glass substrates using SiH_4 + H_2. After deposition, the a-Si:H samples were annealed at 550°C for 5 mm in an N_2 environment to remove all the hydrogen atoms from the films. The samples were then irradiated using a pulsed KrF excimer laser (λ = 248nm) at room temperature. After irradiation, nanoclusters were formed, the cluster sizes of which were characterised using scanning electron microscopy (SEM).

The variation in the poly-Si cluster size was studied using a-Si layers of different thicknesses, i.e. 10, 30, 50 and 70nm. Figs. 1*a–d* show, respectively, the SEM pictures of the surface morphologies of the 10, 30, 50 and 70nm thick a-Si layer irradiated using a KrF laser at a power intensity of 180mJ/cm^2 at one shot. It is clear that the size of the poly-Si clusters increases from 100 to 250nm as the thickness of the a-Si film increases from 10 to 30nm, then decreases from 250 to 35nm as the thickness of the irradiated a-Si film is further increased from 30 to 50nm and stays almost at 35nm as the thickness of a-Si film increased from 50 to 70nm. It is clear that with a small increases in the thickness of the a-Si film of ~30nm, a sharp decrease in the poly-Si cluster size occurs. We propose that when the 10 and 30nm thick a-Si layers on 7059 glass are irradiated by a single KrF laser pulse, they are melted completely by the irradiation and the film assumes a globular shape due to the surface tension. Since the a-Si films are melted completely, the thicker a-Si layer forms thicker globular nanoclusters. As the film thickness increases to 50nm and beyond, the heat generated by the KrF excimer laser may not be able to melt the a-Si film entirely. This leads to random nucleation of the poly-Si on the film surface, thus limiting the size of the cluster.

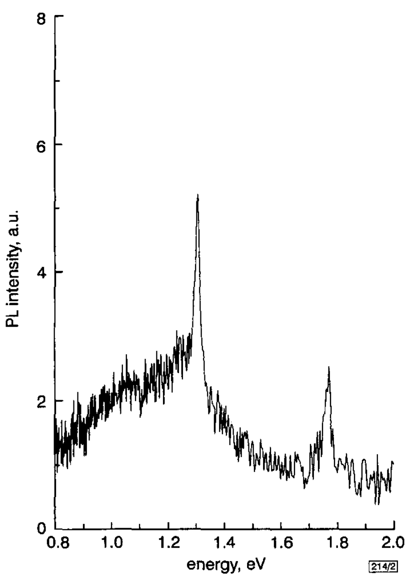

Fig. 2 *Photoluminescence spectrum of irradiated 70nm thick a-Si film with power density of 180mJ/cm^2 at one shot*

The photoluminescence spectra were measured at 63K using the 488nm line of an argon laser as the excitation source. The laser output power was ~3.7mW. Fig. 2 shows the photoluminescence spectrum of the KrF-irradiated 70nm thick a-Si film at a power density of 180mJ/cm^2 at one shot. The spectrum shows two luminescence bands centred at ~1.31 and 1.76eV. Using theoretical calculation, the peak emission wavelengths are found to correspond to the respective ground and first excited state transition from conduction band to valence band within a silicon nanoparticle with a size of ~3–4nm. By adjusting appropriately the power density and shot number of the KrF excimer laser condition, it is in theory possible to manufacture material with a peak emission tailored to the desired application.

We propose a possible mechanism to explain the phenomenon. The heat generated by the KrF excimer laser melts only the surface of the 70nm thick a-Si film, thus forming a liquid-solid interface. The melted Si liquid is globular in shape due to the surface tension, and Si nanoparticles are also formed during the cooling-down period. The globular shape can be attributed to the fact that the agglomeration force of the melted Si is greater than the adherence force to the substrate.

We conclude that the irradiation of an a-Si film using pulsed KrF excimer laser is found to form Si nanoclusters in an a-Si film. The heat generated by the KrF excimer laser melts the surface of the a-Si film, the melted a-Si film becomes globular in shape due to the surface tension, and Si nanoparticles are formed during the cooling-down period. From the photoluminescence spectrum of the 70nm thick a-Si film irradiated by the KrF laser at a power density of 180mJ/cm^2 at one shot, two luminescence bands centred at ~1.31 and 1.76eV are observed which correspond to the ground and first excited state transition of a silicon nanoparticle with a size of ~3–4nm.

Acknowledgment: This work has been supported by the National Science Council of the Republic of China under Contract No. NSC88-2215-E-002-008.

8 September 1999
Electronics Letters Online No: 19991361
DOI: 10.1049/el:19991361

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Self-aligned implanted ground-plane fully depleted SOI MOSFET

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A method for fabricating a back-gate ground plane underneath a thin-film silicon-on-insulator (SOI) MOSFET is described. It is shown by numerical simulation that the formation of the ground plane improves the subthreshold slope and short-channel characteristics of very short-channel devices.

Introduction: It is well known that the dual-gate (top and bottom gate) silicon-on-insulator (SOI) MOSFET is the most suitable device structure for suppressing short-channel effects such as drain-induced barrier lowering (DIBL) and subthreshold slope degradation. Since such devices are difficult to fabricate, alternative structures where a back-gate ground plane is used to reduce short-channel effects have been proposed [1, 2]. In such devices a grounded back-gate prevents the electric field lines originating at the drain from terminating under the channel region, which would cause DIBL and ultimately punch-through. In this Letter a simple, manufacturable process is proposed for fully-depleted (FD) SOI MOSFETs with back-gate ground plane.