Silicon surface passivation by hot-wire CVD Si thin films studied in situ surface spectroscopy

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Deposition Mechanism 1
Chair: Hideki Matsumura
Day: Thursday August 21 Time: 09:00

09:00 – 09:40 Invited Lecture:
Silicon surface passivation by hot-wire CVD Si thin films studied by in situ surface spectroscopy

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Silicon thin films can provide an excellent surface passivation of crystalline silicon (c-Si) which is of importance for high efficiency heterojunction solar cells or diffused emitter solar cells with well-passivated rear surfaces. Hot-wire chemical vapor deposition (hotwire CVD) is an attractive method to synthesize Si thin films for these applications as the method is ion-bombardment free yielding good quality films over a wide range of deposition rates. The properties of the interface between Si thin films and H-terminated c-Si substrates have been studied during film growth by three complementary in situ techniques. Spectroscopic ellipsometry has been used to determine the optical properties, film thickness and surface roughness whereas information on the H-bonding modes and H-depth profile has been obtained by attenuated total reflection infrared spectroscopy. Second-harmonic generation (SHG), a nonlinear optical technique sensitive to surface and interface states, has been used to probe two-photon resonances related to modified Si-Si bonds at the interface. The observations have been correlated with ex situ lifetime spectroscopy experiments. On the basis of the results, the growth and surface passivation mechanism of the films will be discussed, including the role of defect states, built-in electric fields, (nanometer-level) epitaxial growth, influence of the substrate temperature, etc.

09:40 – 10:00
Structural properties of hydrogenated microcrystalline silicon (μc-Si:H) deposited by the hot-wire chemical vapor deposition technique at low substrate temperature

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A series of samples have been deposited at substrate temperature below 200°C by the Hot-Wire Chemical Vapor Deposition (HW/CVD) technique. The temperature of the substrate heater was increased from room temperature (RT) to 200°C and the hydrogen dilution ratio in the silane gas was maintained at 98% while other deposition parameters were kept fixed. This contribution will report on the structural properties of the films deposited. They have been characterized for microcrystallinity by Raman scattering spectroscopy and X-ray diffraction. An average crystalline volume fraction is estimated around 40% with a crystal size ranging between 13.7 and 26 nm. The photoluminescence studies reveal a peak situated at around 1.42 eV in case of high energy excitation and another one at between 1 - 1.2 eV for low energy excitation suggesting that the films are indeed crystalline with a residual network of amorphous silicon. Another additional peak, likely due to the Si-O effects, has been observed at around 1.6 eV. The hydrogen content was estimated by Fourier Transform Infrared spectroscopy at around between 2.9 and 3 at.% in the samples. Additional structural details will be given by the micrographs obtained by our newly acquired High Resolution Cross Section Transmission microscope.