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Analysis of wet chemical tunnel oxide layer characteristics capped with phosphorous doped amorphous silicon for high efficiency crystalline Si solar cell application

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To get high efficiency n-type crystalline silicon solar cells, passivation is one of the key factor. Tunnel oxide (SiO2) reduce surface recombination as a passivation layer and it does not constrict the majority carrier flow. In this work, the passivation quality enhanced by different chemical solution such as HNO3, H2SO4:H2O2 and DI-water to make thin tunnel oxide layer on n-type crystalline silicon wafer and changes of characteristics by subsequent annealing process and firing process after phosphorus doped amorphous silicon (a-Si:H) deposition. The tunneling of carrier through oxide layer is checked through I-V measurement when the voltage is from -1 V to 1 V and interface state density also be calculated about 1 × 10 12cm－2eV－1 using MIS (Metal-Insulator-Semiconductor) structure <Al/Si/SiO2>. Tunnel oxide produced by 68 wt% HNO3 for 5 min on 100ºC, H2SO4:H2O2 for 5 min on 100ºC and DI-water for 60 min on 95ºC. The oxide layer is measured thickness about 1.4~2.2 nm by spectral ellipsometry (SE) and properties as passivation layer by QSSPC (Quasi-Steady-state Photo Conductance). Tunnel oxide layer is capped with phosphorus doped amorphous silicon on both sides and additional annealing process improve lifetime from 3.25 µs to 397 µs and implied Voc from 544 mV to 690 mV after P-doped a-Si deposition, respectively. It will be expected that amorphous silicon is changed to poly silicon phase. Furthermore, lifetime and implied Voc were recovered by forming gas annealing (FGA) after firing process from 192 µs to 786 µs. It is shown that the tunnel oxide layer is thermally stable.

Keywords: tunnel oxide wet chemical oxidation Interface passivation Thermal stability effective minority carrier lifetime