Electrical and optical characterization of protonirradiated GaInP/GaAs/Ge triple-junction solar cells

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ODLTS signal (a.u.)

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acancy density (A

IS measurements

One triple-junction solar cell contains three p-n junctions in Equivalent series and it is difficulty to characterize properties of each one individual junction. Proton irradiation could induce defects, the circuit: distribution of which depends on the proton energy. Based on the selective light-absorption of the three junctions, C_1 C_2 C_3 optical deep-Level transient spectroscopy (ODLTS) technique measured calculated Irradiated by was used to detect the induced defects directly. - top cell - middle cell - bottom cell 130 keV With the simple equivalent circuit selected, capacitance and proton, resistance of each one of the three junctions could be (G) 20000 '7typical obtained by fitting of impedance spectroscopy (IS). impedance **Cole-Cole plot** $hv_{pulse} = 1.90 \text{ eV}$ Mode I for n⁺p GalnP 6000 нтз Z (Ω) HT1 S1: 100 keV S2: 130 keV Frequency measured S3: 170 keV dependence calculated of C and G/ w electrode S (L) O 2x10 G/00 (F) n⁺p - Galn nel iunctio ET n⁺p - GaAs el iuncti n⁺p - <u>Ge</u> 100 200 250 300 350 150 f (Hz) Temperature (K) Obtained capacitances and resistances for $hv_{const} = 1.90 \text{ eV}$ $hv_{pulse} = 1.58 \text{ eV}$ different proton energies 1.4x1 GalnP top cell GaAs middle cell HM₂ 1.2x10 HM1 Ge bottom cell 1.0x10 C/A (F/cm⁻²) S3 HM1 8.0x10 6.0x10 <u>S1</u> 4.0x10 ctrode 2.0x10 0.0 nto - GalnP EM1 10 Mode II for n⁺p GaAs RA (Ωcm²) 10 10⁴ S1: 100 keV n⁺p - GaAs 10³ S2: 130 keV EM2 tunnel junctio 10 S3: 170 keV n+p - Ge 50 100 150 200 250 300 350 Temperature (K) 3950 proton energy (keV) Irradiation Simulation Conclusion top cell middle cell bottom cell 0.024 1. Active energies and concentrations of k e V defects are obtained by ODLTS e V measurements. 0.016 .0025 0.001 Capacitance and resistance of each 2 junction are obtained by IS measurements. 0.008

3.

30000

depth (A)

40000

All the measured variety of concentration depending on proton energy agrees well with the irradiation simulation.