Notes from Spring MRS 2011 – PV

***Tuesday***

**9.15am**: - **Ultra thin Metal/CdTe/AZO solar cells**

Using 200 – 300 nm CdTe layer (nanoparticles)

η = 6%

CdTe has grain size of 50 – 100 nm

Thicker cells showed losses in 400 -600 nm region (high level of grain boundaries)

Post growth annealing treatment; shorter times yielded higher JSC

**2.30pm: - (NIST) – Dual back contact on CdS/CdTe PV**

Traditionally, small wavelengths are lost

Instead, use inter-digitated dual back contacts on back (Platinum)

Electrodeposit CdS on once electrode.

Electrodeposit CdTe on both contacts. (Semiconductors self align onto correct electrodes)

CdCl2 processing resulted in voids at CdS – electrode interface.

Currently working on varying contact metallisation

(metal/?/CdS/CdTe/?/metal)

***Wednesday***

**10.45am: - John Walls (Loughborough) – Characterisation of thin film CdTe PV devices deposited by sputtering**

Can obtain a plasma density of 10 mAcm-2 using opposing pulsed magnetrons. Film thickness controllable to 1 nm. Induced voltage of 30 -50 mV.

400 mm drum, 300 mm x 150 mm glass substrates

ITO – 400 nm , 10Ω/□, < 1 n roughness.

For film growth however, TEC has been used.

Columnar growth of CdTe, which is extremely <111> oriented. Large blisters caused by compressive stress following CdCl2 treatment (400°C).

High number of voids present following CdCl2, recrystallisation -> <220>

Using STEM/EDX, there is evidence that Cl is responsible for blistering

Cell: VOC = 802 mV, JSC = 12.4 mA/cm2, FF = 58%, η = 5 - 6%

*They plan to use reactive gases mid-growth to incorporate Cl.*

***Thursday***

**8.30am: - (Stanford University) – Adhesion and delamination in roll-roll flexible polymer solar cells**

Ag

PEDOT:PSS

P3HT:PCBM

ZnO

ITO

PET

Max efficiency at 50:50 P3HT:PCBM ratio

Each material has differing mechanical and thermal properties. Degradation from thermal stresses and moisture.

A force was exerted to cells in a ‘delaminator’. The ‘crack force’ is measured by beams.

In dense SiO2, need GC = 10J/m2 for crack.

In dense organic, need GC > 10J/m2

In PEDOT:PSS/P3HT:PCBM, need GC < 1J/m2

Fraction energy reduces as PCBM content increases.

To improve adhesion:

- post deposition annealing

- interfacial chemistry

Longer annealing times raise fracture energy (but must keep in mind the compromise to efficiency)

Increased thickness also raises fracture energy but again reduces efficiency.

**8.45am: - Naba Pandel, Al Compaan (Toledo University) – High efficiency CdS/CdTe without CdCl2**

Treatment required for: Recrystallisation, CdSxTe1-x alloying, minority carrier life time enhancement, decrease in grain boundary recombination.

Study effect of Cl, O and extra Cd in smaller grain CdTe films

Glass

SnO2:F/HRT

CdS (80 – 100 nm)

CdTe (2 μm)

Cu/Au

Typically CdCl2 treatment 20 minutes, no chemical etching

For CdTe 2.1 μm and CdCl2 at 387°C: VOC = 845 mV, JSC = 22.6 mA/cm2, FF = 71.9%, η = 13.7%, Area = 0.32 cm2. (back contact – Cu 3 nm, Au 20 nm)

*20 min anneal in dry air:*

Re-crystallisation shown to be possible by simply heat treating the sample at 450°C.

Sulphur content at CdSxTe1-x also comparable to CdCl2 treatment (X = 1.7% in air, X = 2% in CdCl2).

Grain sizes comparable (shown in SEM)

At 450°C

Best: VOC = 791 mV, JSC = 20.9 mA/cm2, FF = 69.7%, η = 11.6%

Avg: VOC = 767 mV, JSC = 19.4 mA/cm2, FF = 66.3%, η = 9.9%

VOC is regained by using a subsequent CdCl2 5 min treatment.

High T (> 400°C) CdCl2 treatment shows sample is overtreated (too much sulphur diffusion).

Increasing CdCl2 treatment from 400 – 450°C: η drops

Increasing air treatment from 400 – 450°C: η rises (further increase resulted in delamination)

CdS and CdTe was deposited at 275°C

**9am: Berg (Luxembourg University) – CZTS**

Achieved 6.1% by improving annealing step

**10am: Braun (Leipzig University) – CIGS large area on polymide substrates**

Over 37.2 cm2, η = 11.6%

(VOC = 59.6 mV)