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This is to certify that **Mr Abdullah Alsulami** has attended the **6th International Conference on Hybrid and Organic Photovoltaics**, held from 11th to 14th May 2014, in Lausanne, Switzerland.

Mr Abdullah Alsulami has presented a Poster contribution entitled "High performance of organic solar cells with solution-processed vanadium pentoxide hole extraction layers"

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High performance of organic solar cells with solution-processed vanadium pentoxide hole extraction layers

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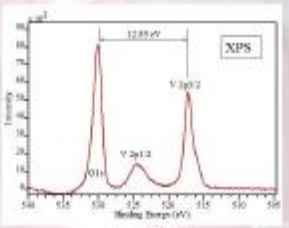
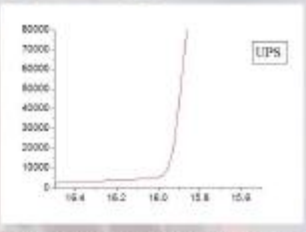
Summary

Transparent metal oxides such as MoO_3, NiO, and V_2O_5 have been used as interfacial hole extraction layers in polymer bulk heterojunction solar cells (OPV) [1, 2]. These materials have exhibited a performance that is similar to or better than PEDOT:PSS layer. Most of the hole transport layers require further treatment after deposition such as thermal annealing or ozone plasma treatment. Here V_2O_5 films were fabricated by a spin-coating solutions of vanadium oxitriisopropoxide precursor at room temperature in air without post-deposition processing.

- AFM scan showed a uniform V_2O_5 surface with a RMS roughness of 1 nm.
- UPS and XPS analysis of V_2O_5 exhibited a work function of 5.2 eV and fully oxidised film.
- Optical characterisation of the V2O5 thin films showed E_g of 2.75 eV.
- OPVs with s-V_2O_5 hole extraction layer, and active layer of PFD2TBT8:PC70BM shows an efficiency of 6.3 (± 0.2) %

Photoelectron spectroscopy





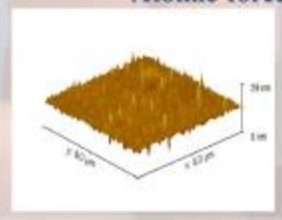
The left figure shows the XPS spectra of the 6-nm s-V_2O_5 thin layer film that was prepared in air. As suggested by Coulston et al., [3, 4] the effective oxidation (or average oxidation) state can be estimated from the following linear relationship:

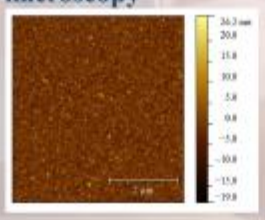
$$V_{OX} = 13.82 \quad 0.68\,[\,E_b(O1s) \quad E_b(V2P_{3/2})]$$

It was found that V_{ox} = 5.05, indicating fully oxidised films.

The right figure shows the position of the secondary electron cut-off of the UPS spectrum exhibiting a work function of 5.2 eV.

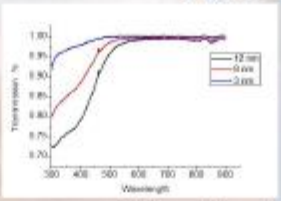
Atomic force microscopy

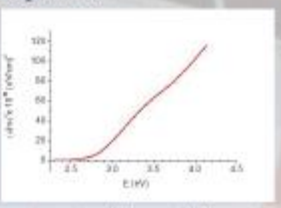




The topography of the V_2O_5 film surfaces were characterised by tapping-mode AFM. The images represent AFM height images of V_2O_5 spin coated on a Si surface with the thicknesses of 12 nm. AFM scan shows a uniform and smooth V_2O_5 surface with a RMS roughness of 1 nm.

Optical properties





The transmittance of different thickness films were investigated. The optical absorption coefficient $(\alpha h\nu)^2$ is plotted as a function of the incident photon energy. From the following relationship [:

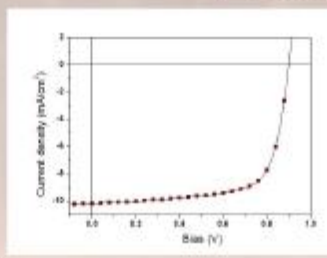
$$\alpha(h\nu) \propto [h\nu - E_g]^{1/N}$$

we determined that the E_g of the s-V_2O_5 film lies at 2.75 eV.

Fabrication processing

- The substrates were cleaned in 3 steps with a water–Hellmanex solution, NaOH solution (10 wt%), and iso-propanol (99%).
- Vanadium oxitriisopropoxide was dissolved in iso-propanol at a concentration of 5 mg/ml. Thin films (~3 nm) of vanadium oxide were deposited via spin coating onto ITO coated glass substrates.
- The active layer was prepared by mixing solutions of PFD2TBT8 and $PC_{71}BM$ at a weight ratio of 1:4 in chloroform with an overall concentration of 20 mg/ml.
- The PFD2TBT8:$PC_{71}BM$ solution then was spin coated at 3000 rpm in a glove box.
- A calcium (5 nm) then aluminium (100 nm) double layer cathode was deposited via thermal evaporation.
- Devices were encapsulated using an inert UV curable epoxy and a glass cover slide.
- OPV devices were measured under ambient conditions using a Keithley 2400 source meter and a Newport 92251A-1000 AM1.5 solar simulator.

J-V characetristic



ITO/sV_2O_5/PFD2TBT8:$PC_{71}BM$/Ca/Al

PCE [%]	6.3 ± 2
J_{sc} [mA cm^{-2}]	10.23 ± 0.12
V_{oc} [V]	0.90
FF [%]	68 ± 1.5
R_s [Ω.cm^2]	13.6
R_{sh} [Ω.cm^2]	590

References

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