Optical and Electrical Characterization of Doped PEDOT:PSS for Hybrid Solar Cell Applications

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Introduction: Module cost accounts for around 36% of the price of current cells at around 40,000 yen/kWh. The high vacuum and high temperature production techniques employed in commercial Si-based solar cells set a limit to lowering prices. Organic-silicon hybrid solar cells can take advantage of low-cost processing techniques of conjugated polymers and the optoelectrical properties of Si to reduce the module cost while maintaining high performance. Achieving parity in efficiency with current inorganic solar cells has the potential to significantly drop the price of solar cells. Poly(3,4-ethylenedioxythiophene):poly(styrenesulfonate) (PEDOT:PSS) has been widely used due to its high conductivity and thermal stability. The high transparency of PEDOT:PSS makes it an attractive transparent electrode or absorber layer. Our previous work focused on achieving a repeatable highly uniform layer on Si and SiO_2 substrates. These films commonly contain dopants like DMSO and X-100 to enhance performance[1-3]. In this study, the impacts that different dopant concentrations have on the optical and electrical properties of the film have been investigated.

Experimental: A highly uniform repeatable set of conditions were devised to obtain a consistent 100 (±15)nm layer of PEDOT:PSS (Clevios F HC Solar) on Si and quartz substrates. Separate formulations of PEDOT:PSS using 1,5,10 wt% of X-100 and 5,7 wt% of DMSO were deposited. The films were annealed over both argon and oxygen gas. The absorbance characteristics of the samples were measured using a UV-vis between 200-1700nm wavelengths. The electrical properties were also tested by using the four probe method on a thin strip of thin-film between 5K to 300K.

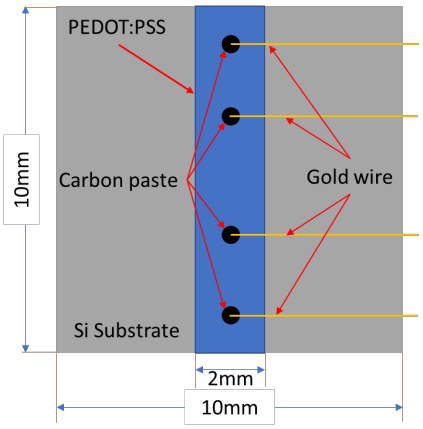

Fig 1. Schematic of four probe method

Results and Discussion: A very uniform coating of 100nm thick layer PEDOT:PSS has so far been achieved. DMSO made no significant changes to absorbance. Slight increases in absorbance of 5% DMSO over 7% DMSO may indicate an overall thicker film. X-100 showed clear peaks between 226-228nm with an isobestic point at 246nm [Fig 2]. This will probably result in parasitic absorption when applied to a solar cell causing a drop in performance. The thin films showed similar electrical characteristics both during rising and falling temperatures. Slight changes were observed in the conductivity of the films in different annealing conditions. More information will be shared during the presentation.

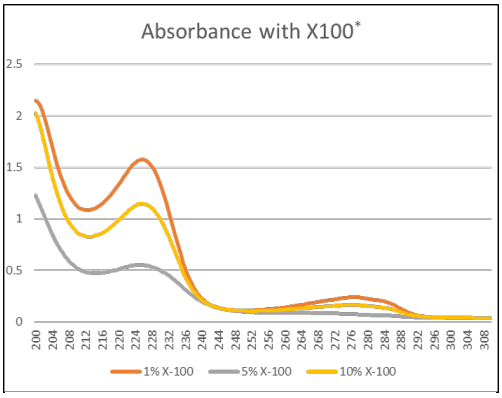

Fig 2. Absorbance characteristics

[1] Jiang et al. *Nanoscale Research Letters (2016) 11:267*
[2] Chen et al. *ACS Appl. Mater. Interfaces 2013, 5, 7552−7558*
[3] Kwang-Tae Park et al., *Scientific Reports (2015) 5:12093*