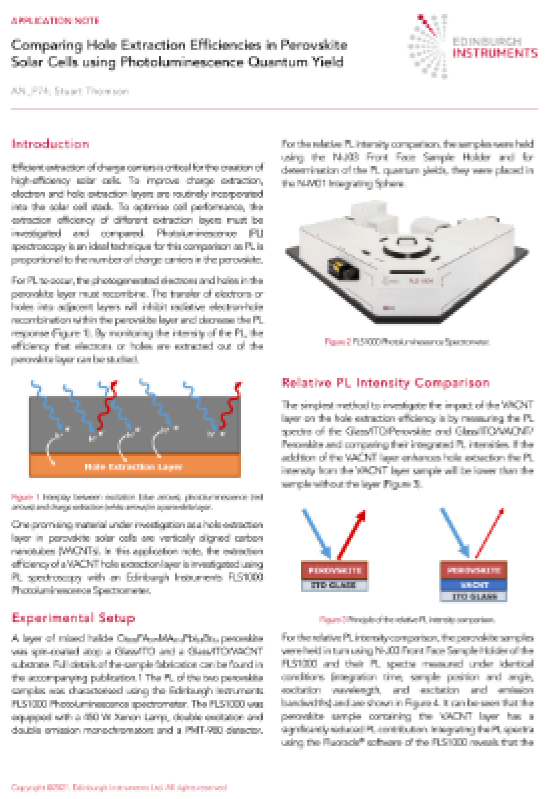
Wednesday, February 9, 2022

PHOTONICS spectra®

WHITE PAPERS & APPLICATION NOTES


APPLICATION NOTE

Comparing Hole Extraction Efficiencies in Perovskite Solar Cells using Photoluminescence Quantum Yield

AN_P74; Stuart Thomson

EDINBURGH INSTRUMENTS

Introduction

Efficient extraction of charge carriers is critical for the creation of high-efficiency solar cells. To improve charge extraction, electron and hole extraction layers are routinely incorporated into the solar cell stack. To optimise cell performance, the extraction efficiency of different extraction layers must be investigated and compared. Photoluminescence (PL) spectroscopy is an ideal technique for this comparison as PL is proportional to the number of charge carriers in the perovskite.

For PL to occur, the photogenerated electrons and holes in the perovskite layer must recombine. The transfer of electrons or holes into adjacent layers will inhibit radiative electron-hole recombination within the perovskite layer and decrease the PL response (Figure 1). By monitoring the intensity of the PL, the efficiency that electrons or holes are extracted out of the perovskite layer can be studied.

Hole Extraction Layer

Figure 1 Interplay between excitation (blue arrows), photoluminescence (red arrows) and charge extraction (white arrows) in a perovskite layer.

One promising material under investigation as a hole extraction layer in perovskite solar cells are vertically aligned carbon nanotubes (VACNTs). In this application note, the extraction efficiency of a VACNT hole extraction layer is investigated using PL spectroscopy with an Edinburgh Instruments FLS1000 Photoluminescence Spectrometer.

Experimental Setup

A layer of mixed halide [illegible] perovskite was spin-coated atop a Glass/ITO and a Glass/ITO/VACNT substrate. Full details of the sample fabrication can be found in the accompanying publication.1 The PL of the two perovskite samples was characterised using the Edinburgh Instruments FLS1000 Photoluminescence spectrometer. The FLS1000 was equipped with a 450 W Xenon Lamp, double excitation and double emission monochromators and a PMT-980 detector.

For the relative PL intensity comparison, the samples were held using the N-J03 Front Face Sample Holder and for determination of the PL quantum yields, they were placed in the N-M01 Integrating Sphere.

Figure 2 FLS1000 Photoluminescence Spectrometer.

Relative PL Intensity Comparison

The simplest method to investigate the impact of the VACNT layer on the hole extraction efficiency is by measuring the PL spectra of the Glass/ITO/Perovskite and Glass/ITO/VACNT/Perovskite and comparing their integrated PL intensities. If the addition of the VACNT layer enhances hole extraction the PL intensity from the VACNT layer sample will be lower than the sample without the layer (Figure 3).

PEROVSKITE
ITO GLASS

PEROVSKITE
VACNT
ITO GLASS

Figure 3 Principle of the relative PL intensity comparison.

For the relative PL intensity comparison, the perovskite samples were held in turn using N-J03 Front Face Sample Holder of the FLS1000 and their PL spectra measured under identical conditions (integration time, sample position and angle, excitation wavelength, and excitation and emission bandwidths) and are shown in Figure 4. It can be seen that the perovskite sample containing the VACNT layer has a significantly reduced PL contribution. Integrating the PL spectra using the Fluoracle® software of the FLS1000 reveals that the

Copyright ©2021. Edinburgh Instruments Ltd. All rights reserved.

Comparing Hole Extraction Efficiencies in Perovskite Solar Cells using PLQY

Efficient extraction of charge carriers is vital for the creation of high-efficiency solar cells. Photoluminescence is proportional to the number of charge carriers in the perovskite and sensitive to charge transfer into adjacent layers. This makes PL based techniques invaluable for investigating the performance of new extraction layers. In this app note, the extraction efficiency of a VACNT hole extraction layer is investigated using PL spectroscopy with a Photoluminescence Spectrometer.

DOWNLOAD WHITE PAPER

EDINBURGH INSTRUMENTS

More White Papers from This Sponsor

- X-ray Excited Luminescence Lifetime of Scintillators
- Time-resolved Spectroscopy of Phosphorescent Oxygen Sensors in a Relevant in-vitro Environment for Biomedical Applications
- Raman Spectroscopy as a Tool for Studying Polymer Phase Transitions

Visit **Photonics Media** to download other white papers and learn more about the latest developments in lasers, imaging, optics, biophotonics, machine vision, spectroscopy, microscopy, photovoltaics and more.

www.photonics.com/WhitePapers.aspx
