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Final Report

Name: Ramos Vences, Alejandra

I have had the opportunity to be hosted by Prof. Dr. Jürgen Gutowski and his Semiconductor Optics research group of the Institute of Solid State Physics, Faculty of Physics and Electrical Engineering, University of Bremen, given the close collaboration with my thesis supervisors Dr. Jairo C. Nolasco and Dr. Alejandra Castro-Carranza.

The general goal of my four-week research stay in the Semiconductor Optics group was to carry out optical and electrical characterization of samples based on CuO deposited on indium tin oxide (ITO) substrates. The CuO samples were fabricated in Mexico and they consist of heterojunctions formed by PCBM/CuO bilayers on ITO and contacted by Ag electrodes. While PCBM is an n-type small-molecule organic semiconductor, CuO is p-type. Their junction forms a diode suitable and promising for solar cell applications.

The following activities were done in this research stay:

First week:

- Laboratory safety course.
- Bibliographic research.
- Preparation of the setup to measure impedance spectroscopy.
- Electrical characterization of solar cells.

Second week:

- Bibliographic research on Atomic Force Microscopy (AFM) and photoluminescence (PL).
- Thickness measurements of the CuO samples using an Atomic Force Microscope.

This characterization technique is a powerful tool for the study of surfaces in the nanometer range. Via these measurements we could estimate the thickness variations of the three layers of the samples: CuO, Polystyrene and PCBM.

Third week:

- Bibliographic research of photoluminescence characterization for CuO
- Preparation of photoluminescence setup

- Micro-photoluminescence characterization of CuO and ZnO samples

Photoluminescence is carried out to study the recombination of charge in the samples, affected by the layer morphology or architecture of the device. Specifically, it was possible to determine the passivation effect and the influence of the PCBM layer on the performance of the samples.

Fourth week:

- Bibliographic research on photoconductivity
- Preparation of the setup to measure photoconductivity
- Photoconductivity on CuO samples

As a result of this characterization we have verified the mechanisms of recombination. The density of defect states due to the addition of layers in the devices is being analyzed in order to conclude the optimal technological parameters to fabricate solar cells based on CuO We plan to prepare a scientific contribution either for a congress and/or a journal.

I would like to acknowledge the friendly working environment in the Semiconductor Optics group; its members have been very helpful and open for discussions on the different challenges during the experimental work. Also, I would like to stand out that my stay has been part of the collaboration initiated between the Faculty of Physics and Electrical Engineering (FB1) and ENES Morelia UNAM Mexico, established officially through the cooperation agreement (CM-CSAM-UJ-CV-I-06-026/2018) signed in November 2018. I am convinced that this experience and the results obtained will serve to foster stronger links between both universities and benefit for both countries.

I gratefully thank Dr. Jairo C. Nolasco, Dr. Alejandra Castro Carranza, and the Mapex Center for Materials and Processes for giving me the opportunity to carry out this research stay. Without their respective supervision and support, this would not have been possible.

I am sure this experience will add a great value to my personal and professional development, and will be very helpful for my future projects.