KENT STATE UNIVERSITY

KENT STATE UNIVERSITY PHYSICS COLLOQUIUM

Thursday, May 5, 2016
1:30pm
Smith Hall 111

Refreshments @ 1:15 pm

Professor Alexander Zakhidov

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CARRIER TRANSPORT AND RELIABILITY ISSUES IN PEROVSKITE SOLAR CELLS

Organic-inorganic halide perovskites made a revolution in thin film solar cells. $CH_3NH_3PbX_3$ (X = Cl, Br, or I) perovskites made a rapid progress in power conversion efficiency from 3.8% in 2009 up to >21% in 2016. I will make a quick review on that topic and try to explain why this particular class of materials outperforms organic solar cells and what are the challenges facing practical application.

In particular, I'll discuss the mechanism of perovskite thermal decomposition on ZnO electron transport layer (ETL). ZnO ETL for perovskite photovoltaics has a combination of attractive electronic and optical properties: i) the electron affinity of ZnO is well aligned with valence band edge of the $CH_3NH_3PbI_3$, ii) electron mobility of ZnO is >1 $cm^2/(Vs)$, which is a few orders of magnitude higher than that of TiO_2 (another popular choice of ETL for perovskite photovoltaic devices), and iii) ZnO has a large of band gap of 3.3 eV, which ensures optical transparency and large barrier for the hole injection. Moreover, ZnO nanostructures can be printed on flexible substrates at room temperatures in cost effective manner. However, it was recently found that organic perovskites deposited on ZnO are unstable and readily decompose at >90˚C. In our recent, we further investigate the mechanism of decomposition of $CH_3NH_3PbI_3$ film deposited on ZnO and reveal the role of the solvent in the film during the annealing process. We also develop a restricted volume solvent annealing (RVSA) process for post annealing of the perovskite film on ZnO without decomposition. I will also present theoretical results of our recent study, where we have predicted existence of self-trapped polarons in the $CH_3NH_3PbI_3$ perovskites using DFT+U methodology.

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