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Dirección de Formación Académica

CENTRO DE INVESTIGACIONES EN OPTICA, A.C.

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Tesis: **"INTERFACIAL ENGINEERING OF PEROVSKITE SOLAR CELLS USING ADVANCED NANOMATERIALS AND QUANTUM DOTS"**

Resumen:

Hybrid organo-halide lead perovskites have achieved a power conversion efficiency exceeding 22% in a period of less than a decade and is in the path of replacing the well-established thin film photovoltaic technologies. The major bottleneck for perovskite devices has been to obtain a uniform morphology with reduced surface defects and the absence of standardized interface materials, and interfacial engineering methods which can be utilized for large area production with reduced hysteresis and low interfacial losses. Hence, developing a novel concept for solution processed, reliable, cost efficient, and improved electron or hole transportation using different state of the art advanced nanomaterials and quantum dots along with some interfacial engineering strategies was the way to go without compromising efficiency, stability and scalability, becoming of paramount importance.

The first part of the work deals with using advanced strategies for improving the morphology of the perovskite active layer in a regular mesoscopic and inverted planar solar cell. Initially the anti-solvent deposition method using ethoxyethane was optimized in terms of the dripping time to obtain a uniform, pin-hole free coverage of the perovskite film. After obtaining a uniform coverage, a concentrated effort to increase the grain size of the perovskite film reducing the surface and bulk defects were undertaken. A novel air-extraction based anti-solvent deposition (AAD) strategy using an air-extractor fume hood with optimized distance was compiled in the ambient conditions to obtain a perovskite grain size of ~ 1 μm with reduced surface defects and enhanced efficiency. Further improvement was achieved by cesium doping in the perovskite active layer leading to grain sizes of few micrometers. The cesium ion helped in retarding the crystallization process by forming an adduct with the reactants of the perovskite (PbI2 and CH3NH3I) leading to enhanced grain size with reduced defects. Finally a bromine based post annealing treatment method was developed to attain a grain size of ~10 μm by Ostwald ripening process with flat grain boundaries.

The second part of the work deals with the use of advanced nanomaterials along the interfaces or within the transport layers for improving the charge carrier injection and extraction. It describes different strategies utilized for incorporating these materials or dopants within the electron or hole transport layer without affecting its quality. In the first case, graphene nanoplatelets were introduced in the TiO2, using a simple solution process followed by a post sintering step. The presence of graphene nanoplatelets helped in improving the morphology of the overlying perovskite film and increased the charge carrier mobility to balance the mismatch in charge carrier extraction between the electron and hole transport layer. Further, a doping strategy was developed with the Co(III) ions being incorporated within the lattice of TiO2 passivating the oxygen vacancies and