Summary of thesis:

The work presented in this thesis is part of the work of the Laboratory of New Materials for Photovoltaic Energy in the main target to use new techniques of elaboration with low cost and using CIGS and Perovskite materials for solar photovoltaic application. This aims to contribute to the development of the exploitation of solar energy for electrical energy by many people around the world. Recently, the enhancement of solar cells efficiency with low cost is a leading to scientific research challenge. Copper, indium, gallium, and selenium (CIGS) solar cells seem to be suitable with low cost and simplified of manufacture. Freshly, Cu (In,Ga) $(Se, S)_2$ device record cell efficiency of 23.35% for thin films solar cells and the efficiency still be boosted. In other hand, Organic-inorganic lead halides perovskites ($APbX_3$) have currently and exceptionally appeared as new materials for low cost thin film solar cells specially that the efficiency of perovskite based solar cell have jumped from 3.8% to 22.7% in short time.

In this present work, we report here the experimental investigation on elaboration and characterization chalcopyrite Copper, indium, gallium, and selenium (CIGS) While electrochemical technique and spray pyrolysis as well as methylammonium lead iodide perovskites ($MAPbI_3$) and formamidinuim iodide lead iodide perovskites ($FAPbI_3$) thin films were deposited using the spin coating process for perovskite-based solar cells application and Tandem CIGS-perovskites.

The thin films prepared were characterized by UV-Vis spectroscopy, X-ray diffraction (XRD), Raman spectroscopy (RS), scanning electron microscopy (SEM) and energy dispersive spectroscopy (EDS) analysis, atomic force microscopy (AFM), transmission electron microscopy (TEM), Photoluminescence analysis (PL) and UV-Vis spectroscopy,

The first part of this investigation was devoted for the effect of different parameters on the growth of Cu (In, Ga) $(Se, S)_2$ grown by electrodeposition. the CIGS absorber film is deposited in one step to optimize the deposition parameters like deposition potential, deposition time and overvoltage of hydrogen on the surface of the deposited cathode also the parameters related to solution such us the concentrations of the precursors and the temperature of the bath and the pH of the solution also we investigate in details the impact of different back contact was in structural and optical proprieties CIGS thin films. The back contact has a significant effect for the fabrication of CIGS thin films for photovoltaic application.

In a second stage we report the effect of spray pyrolysis technique to control the growth of CIGS films for solar cells application. The chapter is containing two part, first we will study the

effect of experimental parameter like the concentration of precursors also the annealing process which is the key factor for Improving the performance of solar cells, In the second part, we will investigate the performance of solar cell CIGS, grown by the spray technique, by simulator Scapes to have idea about the efficiency of solar cell before the realization of CIGS solar cell .in this stage we elaborated different thin films constituted CIGS-based solar cells deposited by different techniques. In the objective to accomplish higher power conversion efficiency of the device CdZnS/CdS/CIGS/Mo, the window layer (ZnO, CdZnS) and the buffer layer CdS should transmit a large number of photons to reach the absorber layer and generate electrons holes pairs. The approach is to realize another material to change the toxic ZnO by using correctly the CBD technique. Moreover, our device CdZnS/CdS/CIGS/Mo used a transparent, conductive CdZnS layer with optimizing the amount of doped materials, which makes it easy to minimize the interface alignment and to illuminate the p-n junction.

In other hand, Organic-inorganic lead halides perovskites MAPbI3 and FAPbI3 was investigated in order to optimize the chemical composition and to study the crystallization process also to get sight about the stability of perovskite materials to meet the requirement of their application as an active layer in perovskite solar cell. For this purpose, Crystallization is accomplished by slowing down the solubility in a saturated solution by Adding different amount of diethyl ether Anti-Solvent. the $MAPbI_3$ film surface was treated by adding diethyl ether antisolvent with different rates that directly influences the level of supersaturation and thermal annealing. during the treatment complex exchanges are appearing at the same time under the influence of quite a lot of physicochemical properties. A whole understanding of this topic is critically important for improving solar cell performance. The obtained $MAPbI_3$ perovskite thin films were investigated their optical and electricals properties. The main objective to increase the stability of $MAPbI_3$ thin films, the tetrabutylammonium (TBA) can be successively incorporated into $MAPbI_3$ perovskite films prepared by spin counting technique, boosting the formation of perovskite structure, leading to a higher orientation along the (110) and the identification phase in 110 cm^{-1}.TBA Doped $MAPbI_3$ film shows better crystallinity, large grain size, pinhole-free surface morphology and good roughness, which is suitable for the manufacturing of the optoelectronic devices with higher performance. Also, we have identified the impact of TBA in the photo-physical properties of $MAPbI_3$ perovskite films using photoluminescence technique and UV visible spectroscopy. We have noticed that the TBA improve the photoluminescence

emission by reducing the density of trap states and the optical absorption indicates a significant shift to the lower wavelength and optical bandgap varied from 1.8 to 1.52 eV. Finally, the stability was explored for 5% TBA, it found that after 15 days the stability remained excellent in a humid environment (relative humidity of ~60%). These results would be helpful for realizing stable and high performance $MAPbI_3$-based devices. Furthermore, we investigate the Formamidinium lead iodide ($FAPbI_3$) like one of the most attractive perovskite materials, herein we inspect the effect of monovalent cation substitution of Guanidinium (GA) on the structural and optical properties of Formamidinium lead triiodide ($FAPbI_3$) thin films perovskites. The ratio between the desirable and black perovskite α-phase and the undesirable δ yellow phase is studied as a function of GA content. GA doping is shown to be efficient in the control of α/δ phases ratio and then in the stabilization of the α-$FaPbI_3$ phase. We qualitatively evaluate the impact of 10% of guanidinium on the phase composition and microstructure of films by analyzing perovskite thin films by X-ray diffraction, atomic force microscopy, transmission electron microscopy, photoluminescence and UV-visible spectroscopy. The results show that an adequate amount of 10% GA: $FaPbI_3$ leads to a homogeneous perovskite film with stable α phase, large grains, and free pinholes. 10% GA: $FaPbI_3$ films demonstrate excellent stability after aging for 15 days in a humid environment (relative humidity of ~60%).