POSTER: Evaluation of the optoelectronic properties of $ZnSnN_2$ thin films under different growth conditions and doping implantation of As and P at different concentrations

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The market in the photovoltaic (PV) domain is nowadays dominated by crystalline silicon (c-Si). However, the production of c-Si cells and modules is rather costly in terms of energy. That is why other materials, to be used as absorbers in the cells, have been the subject of intense studies in the last decade. Some of these materials revealed poor conversion efficiency, like hydrogenated amorphous silicon, others contain components which are not harmless for the environment, like Pb in perovskites or Cd in Cadmium telluride cells, and others contain scarce components, such as gallium or indium, the shortage of which could be an issue in the near future.

That is why the ANR project OPERA [1] has chosen to investigate on the development of a new kind of low-cost, indium/gallium-free, non-toxic nitride absorber produced by sputtering, an easy-to-use, up-sizeable and cost affordable technique. Indeed, the family of Zn-IV-N_2 alloys is promising as it could span the solar spectrum and could then replace the InGaN alloys as absorbers [2]. Nonetheless, data about Zn-IV-N_2 alloys remain scarce. The interest of these alloys for photovoltaics has increased during the last three years, but numerous efforts remain to be done to better understand its fundamental properties.

In this work, we focus specifically on $ZnSnN_2$. A previous study [3] analyzed the photoconductivity properties of the material deposited under different gas species (N_2+Ar or N_2+H_2) and also after implanting the following doping elements in the material: As, B, C, F, P and Si. It was concluded that the material deposited under N_2+Ar, and doped with As and P, presents the highest values of photoconductivity. Based on this results we procced to analyzed the electrical and photoconductivity behavior of new samples implanted with As and P at different concentrations. A comparison with the previous results will be given, and we will also present a simple model to explain the observed electrical behavior.

Moreover, using absorption/transmission measurements, we also observed a notable variation in the optical properties of the material when a bias is applied to the substrate during the deposition. Some preliminary results will also be presented about the bias influence on the material characteristics.

[1] ANR-17-CE05-0022 « Nouveaux matériaux absorbeurs pour cellules solaires en couche mince à base d'éléments abondants et à faible empreinte environnementale ».
[2] T. Perin *et al.*, "Prospective analysis of optoelectronic properties of $ZnSnN_2$ for future tandem solar cells", Journées Nationales du PhotoVoltaique 2017.
[3] S. Le Gall *et al.*, "Etude des propriétés de photoconductivité de couches minces de $ZnSnN_2$ par implantation de dopants et selon différentes conditions de croissance", Journées Nationales du PhotoVoltaique 2018.