

DocMASE Project Proposal 2015-UL

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| Project Title | PhD subject: Elaboration and characterisation of new p-type TCO thin films |
| Main University and Advisor | University of Lorraine (France) Ass. Prof. Dr. Jean Françoise Pierson |
| Second University and Advisor | Saarland University (Germany) Prof. Frank Mücklich |
| Project Description (with image , if applicable) | <p>Many applications require the use of electrodes which are also optically transparent (PV, touch screens, electrochromic devices,...). Nowadays, the various industrial materials all exhibit a n-type behaviour whereas with an electrical conduction is achieved by means of electrons. One can cite for instance the indium-tin oxide, fluorine doped tin oxide or zinc oxide doped with aluminum. However, the literature also reports p-type transparent conductors where the charge transport is provided by the holes. The delafossite CuAlO₂ is the first p-TCO (transparent p-type conductive oxide) reported in the literature and is still one of the best p-TCO solution. This type of material is not yet commercially available due to its difficulty to be deposited in thin film form at low temperature and still exhibits much lower conductivities than the n-TCO counterpart due to the high stability of the holes in the valence band dominated by the 2p atomic orbitals of oxygen. The development of new efficient p-TCO is the key issue to be solved in order to consider a new generation of optoelectronic devices based on all inorganic and transparent p/n junctions. The development of such devices could have a strong impact on the conventional industry of electronic and could open a wide field of investigation extending beyond the current technology of semiconductor silicon (transparent electronic).</p> <p>Description of the work</p> <p>Transition metal oxide thin films will be deposited by reactive magnetron sputtering at low temperatures (<300 °C) on low cost substrates. The deposition reactor is connected to an ultra-high vacuum pipe of 70 m length that connects about 25 chambers for thin film elaboration (sputtering, MBE, PLD, ALD) and characterisation (SEM, XPS, Auger, AFM, STM, Ellipsometry, Kerr effect, ...). The structure of the films will be studied by X-ray diffraction and Raman spectrometry. The film microstructure will be characterised by transmission electron microscopy. Optical and electrical properties of p-TCO films will be also measured. To tune the optical band gap of the films, metallic or nitrogen doping will be performed. The precise location of the dopants will be determined using atomic probe. During the last year of the PhD, transparent p/n junctions will be synthesised.</p> |
| Requirements of the candidates / Requirements during the doctoral programme (courses, seminars, etc.) | The candidates should have a Master degree in Material Science or Physic Solid State. Previous knowledge about thin films are welcomed. There is no need to have skills in french or german langages. |