A Barnabe et al., Res. Rev. J Mat. Sci. 2017, 5:7
DOI: 10.4172/2321-6212-C1-011

p-type TCO thin films of Delafossite $CuCrO_2$:Mg by rf sputtering with conventional thermal and ultra-rapid laser annealing

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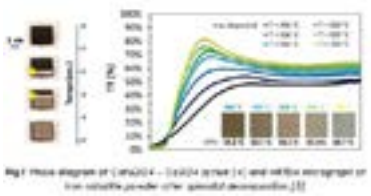
Currently there is a lack of a p-type materials with comparable combinations of high conductivity and transparency to established n- TCO. This technological gap imposes many constraints on the conception and performance on optoelectronic devices which require a transparent hole injection, collection or transport layer. For p-TCO, it is first necessary to deposit the resultant material as a thin film on a transparent substrate. This has been already published using a large range of deposition conditions and technics. However, the main p-TCO performance still needs improvements to, in fine, reach that of their n-TCO counterparts. Second, proper control of the substrate temperature is required and may become an important issue for realistic applications since conventional or flexible substrates are required. The growth of $CuCrO_2$:Mg delafossite thin film on quartz substrate by rf sputtering is first reported in this work. The deposition leads to a nanocrystalline phase. Delafossite characteristic diffraction peaks were obtained as a function of the thermal treatment. The electrical conductivity was optimized until 1.6 S cm^{-1} with an optical transmittance of 63% in the visible range. The transport properties were analyzed by Seebeck and Hall measurements, integrated spectrophotometry and optical simulation. The second part of this work is focused on the post laser annealing which was carried out by varying the scan speed, power and number of pass of the laser beam on films deposited on various polymer, conventional glass and quartz substrates. The laser annealing affects the microstructure, sheet resistance, and optical transmittance of the $CuCrO_2$:Mg thin films. From the present work it can then be concluded that the preparation of efficient p-type TCO thin films based on Delafossite structure could be obtained at temperatures compatible with the use of cheap substrates such as flexible polymer or conventional glass slides.



Biography

A. Barnabé is a professor at the CIRIMAT laboratory (Mixed Oxide Valency research group), Paul Sabatier University, France. He received his PhD degree in chemistry of materials from University de Caen-Basse Normandie (France) in 1999. He held a post-doctoral position in Northwestern University, Evanston (USA), in 2000. His current research interests are mainly focused in functional metal oxide powders, ceramics and thin films prepared by PVD technique. He first worked on TEM characterization of giant magnetoresistance manganites then moves to complex oxides with new optoelectronic properties. For the last decade, he has developed transparent conductive oxides (n- and p-type) and gas-sensing layers for the CO2 detection sputtered oxide thin films. He's in charge on the SEM/TEM/EPMA/SIMS characterization center R. CASTAING in Toulouse. To date, all these works have led to 63 publications, 2 patents, and more than 80 communications (hindex = 22, sum of the times cited > 1400).

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