

The origin of the p-type conductivity in thin films of copper chromium delafossites deposited by Metal-Organic Chemical Vapor deposition investigated by Positron Annihilation Spectroscopy

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Commercially available transparent n-type semiconductors are characterized by electrical conductivities around 10^3Scm^{-1} and by transparencies up to 90% in the visible range. The quest for p-type semiconductors with similar properties has generated a strong interest in copper based delafossites CuMO_2 (where $M = \text{Al, Cr, B, Ga or In}$). Indeed, CuAlO_2 was the first reported p-type semiconductor with an acceptable level of optical transparency [1] and since then a record value for electrical p-type conductivity in Mg doped CuCrO_2 has been reported [2]. However, in order to optimize the optoelectronic properties of these materials, a good understanding of the origin of the p-type conductivity is required. Among the main candidates, the Cu vacancies [3] and O interstitials [4] have been suggested.

In this work, thin films of copper chromium delafossites deposited on Al_2O_3 substrates by the Metal-Organic Vapor Deposition method have been studied. In some instances, a subsequent thermal annealing at 900°C under the same gaseous conditions as during deposition was performed. Doppler Broadening Positron Annihilation Spectroscopy (DBPAS) measured with the slow positron beam developed at CEMHTI was then used to characterize these samples. The positron annihilation characteristics measured in the as-deposited films are seen to evolve upon annealing and this evolution is compared to results obtained by electrical measurements, X Ray Diffraction Spectroscopy, and Scanning Electron Microscopy. This combined approach allowed us to establish the origin of the p-type conductivity in these samples.

References

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