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ZnO films by electrodeposition: growth and optical and thermoelectric properties

C.V. Manzano^{*1}, O. Caballero-Calero¹, B. Abad, P. Díaz-Chao, S. Hormeño, M. Penedo,
B. Alén¹, M. Luna, M. S. Martín-González¹

¹ IMM-Instituto de Microelectrónica de Madrid (CNM-CSIC), Isaac Newton 8, PTM,
E-28760 Tres Cantos, Madrid, Spain *

Email of corresponding author: cristina.vicente@imm.cnm.csic.es

ZnO films have been electrodeposited at constant and pulsed potential at 80°C. Two different solutions were used in order to obtain a comparative study of these sources of OH⁻: nitrate and peroxide solutions. The structure, composition, morphology, optical and thermoelectric properties have been investigated as a function of the solution used and the applied potential. X-Ray Diffraction confirms that the films are pure ZnO oriented preferentially along the [0001] direction. Depending on the conditions used different morphologies have been identified without further addition of additives.

A consistent model that explains the emission of defects for the different electrodeposited ZnO films is proposed.[1] We have associated the green and yellow emissions to a transition from the donor OH⁻ to the acceptor zinc vacancies (V_{Zn}⁻) and to interstitial oxygen (O_i⁰), respectively. The orange-red emission is probably due to transitions from the conducting band to O_i⁻ and O_{Zn}⁰ defects and the infrared emission to transition from these O_i⁻²⁻ and O_{Zn}^{0/-} defects to the valence band.

ZnO film grown at pulsed potential has been analysed by Kelvin probe force microscopy (KPFM). The conductivity is very different inside the individual grains and in the boundary between grains. Grain boundary presents a resistive behaviour and a voltage drop occurs. [2] Thermoelectric properties of ZnO films have been also measured. Seebeck coefficient and electrical resistivity of the best films obtained is presented for both as grown and after treatment at 150°C films. It can be concluded that the Seebeck coefficient increases with temperature. The highest resistivity is found in films grown by pulsed-potential. The resistivity is constant after annealing at 150°C, when no more OH⁻ or H₂O content is left in the films. The measurements have been carried out in a bi-layer ZnO / Au, so the comparison between different ZnO films is qualitative.

References:

- [1] C. V. Manzano, D. Alegre, O. Caballero-Calero, B. Alén, M. S. Martín-González. "Synthesis and luminescence properties of electrodeposited ZnO films". Journal of Applied Physics 110, 043538 (2011).
- [2] C. V. Manzano, O. Caballero-Calero, S. Hormeño, M. Penedo, M. Luna, M. S. Martín-González submitted