Seminar

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Institute for Plasma Research

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Title: On the Growth and Structure of Nano-structured Zinc Oxide Thin Films in Sol-gel Spin Coating

Speaker: Dr. Nimitha K Vijay
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Date: 14th August 2024 (Wednesday)

Time: 03:30 PM

Venue: Seminar Hall, IPR

Abstract

Zinc Oxide (ZnO) is a wide direct bandgap (3.37 eV) transparent conducting oxide with a high exciton binding energy (60 meV) at room temperature. ZnO forms a variety of nano-structures depending on the deposition conditions and techniques which makes it suitable for a wide range of applications. In-room temperature the thermodynamically stable structure of ZnO is wurtzite. Quite contrary to the expectation, ZnO thin films show stable polar planes grown preferentially oriented along (0001) direction (*c*-axis). The polarization can cause quantum confined stark effect that deteriorate its quantum efficiency thus affects its opto-electronic properties. To overcome this, non-polar ZnO surfaces, mainly *a*-axis oriented ones, with controlled defect population is proposed as an alternative. In this talk we discuss the growth and characterization of non-polar, *a*-axis-oriented ZnO ultra-thin films on glass substrates using by sol-gel spin coating. In this method a wet-film of the colloidal sol of ZnO nano-particles are deposited on the substrate using spin coating which is annealed to form solid thin films. The key parameters that influence the growth are: (1) angular velocity of the coater, (2) viscosity of the solution, (3) molarity of the solution, (4) angular acceleration of the coater and (6) annealing temperature. We show how these parameters influence the growth and orientation of the films in a systematic way and how we arrive at a preferred non-polar plane growth [1]. To address this, experiments were carried out for a range of angular speed between 1000 RPM to 5000 RPM, molarity from 0.2 M to 1.0 M solution with an annealing temperature ranging from 200 ^{0}C to 500 ^{0}C. The structural, morphological and optical properties of the films were characterized using XRD, TEM, FESEM, FTIR, UV-vis and spectroscopic ellipsometry. The defects in the samples were analyzed using photo-luminescence and positron annihilation spectroscopy. The study confirms the formation of highly textured a-axis orientated ultra-thin (< 15 nm) films of ZnO [2,3]. A phenomenological model has been developed to explain the observed dependencies of these parameters in the growth, structure and other properties of these films. The details of how the deposition conditions influence the growth, texture coefficient, optical properties and defects of these films will be discussed in the talk.

References:

1. N. Vijay, P.N. Maya, S. Akkireddy & M.D, Benoy, Thin Solid Films 762 (2022) 139554
2. N. Vijay, P.N. Maya, S. Mukherjee et al., J. Phys.: Condens. Matter 36 (2024) 135002
3. N. Vijay & M.D. Benoy, AIP conference proceedings, 2263 (2020), 050001