In situ X-ray studies of the early stage of ZnO Atomic Layer Deposition on InGaAs and lamellar dichalchogenides

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In the microelectronics industry, Atomic Layer Deposition (ALD) is widely employed for the growth of conformal thin films with sub-nanometer thickness control, as it can be performed at the low temperatures compatible with industry specifications. An outstanding problem in the ALD community is understanding how to reproducibly synthesize an ultrathin layer on a given substrate with the desired structural and electronic properties. Achieving this requires precise understanding of the surface chemistry, growth and crystallization mechanisms that take place.

We will report on the fabrication of nanometer thick ZnO films used as tunneling insulators at the metal-$In_{0.53}Ga_{0.47}As$ (InGaAs) heterojunction [1,2] and Titanium disulfide (1T-TiS_2) which belongs to the layered transition metal dichalcogenide family (TMDC), with electrical properties ranging from semiconductor to semi-metallic [3]. Exploiting an unique ALD chamber built to mount onto an heavy duty X-ray diffractometer [4], we have conducted a suite of *in situ* synchrotron X-ray experiments to reveal the atomistic and microstructural processes taking place during the growth of ALD ZnO on InGaAs from 0 to ~10 nm in film thickness, and to study a 2-steps synthesis of TiS_2 ultra-thin films on 100 nm thick SiO_2, by molecular layer deposition (MLD) and thermal treatment [5].

The approach and techniques we employ are broadly applicable to a wide range of other oxides/semiconductor systems, ultrathin films and lamellar 2D materials.

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