



Optical properties of ALD deposited ZnO as functional sensing layer based on self-assembled mesoporous membranes

Master's thesis

Katharina Spangenberg

November 2017

**Institute of
Materials Physics
Group Wilde**

Optical properties of ALD deposited ZnO as functional sensing layer based on self-assembled mesoporous membranes

A thesis presented for the degrees

Master of Science

&

Máster Universitario en Ciencia y Tecnología de Nuevos Materiales

1st supervisor: Prof. Dr. Gerhard Wilde

2nd supervisor: Prof. Dr. Svetlana Ivanova

Contents

1	Introduction	1
2	Theory	5
2.1	Anodic aluminum oxide (AAO)	5
2.1.1	Structural and chemical properties	5
2.1.2	Photoluminescence	8
2.2	Zinc oxide (ZnO)	10
2.2.1	Structural and chemical properties	10
2.2.2	Photoluminescence	12
3	Experimental procedures	15
3.1	Sample preparation	15
3.1.1	Synthesis of AAO templates	15
3.1.2	Atomic layer deposition (ALD)	18
3.2	Characterization techniques	21
3.2.1	Scanning electron microscopy (SEM)	21
3.2.2	Energy dispersive X-ray spectroscopy (EDX)	22
3.2.3	Atomic force microscopy (AFM)	23
3.2.4	X-ray diffraction (XRD)	25
3.2.5	Optical spectrometry	28
4	Results & Discussion	31
4.1	Morphology	31
4.1.1	Pore diameter	33
4.1.2	Thickness of the AAO membranes	35
4.1.3	Thickness of the ZnO layers	37
4.1.4	Surface roughness	39
4.2	Chemical composition	41
4.3	Crystal structure	43
4.4	Microstructure	46
4.5	Photoluminescence	52
4.5.1	AAO	52
4.5.2	ZnO	58
5	Summary & Conclusions	69

Contents

6 Outlook	73
A Appendix	75
Bibliography	81