Table of contents

Abstract (English) 6
Resumen (Castellano) 8
Resum (València) 10
List of Figures 14
List of Tables 18
Preamble 19
Introduction 20
References 25
CHAPTER I 26
General information and theoretical framework 26
1 General information on semiconductor nanocrystals 27
1.1 Quantum Dots 27
1.2 Semiconductor material 29
1.3 Structural properties of semiconductor 30
2 Properties of Quantum Dots 32
2.1 Effect of the size and quantum confinement properties 32
2.2 Optical properties of Quantum Dots 38
2.2.1 Emission wavelength 38
2.2.2 Absorbance and photoluminescence 39
2.2.3 Photoluminescence 42
2.2.4 fluorescence 42
3 Applications of Quantum Dots 43
4 The choice of the material and Different pathways of InP synthesis 44
4.1 The Choice of indium phosphide Quantum Dots 44
4.2 Methods to synthesis nanocrystals (NCs) 46
4.2.1 Synthesis in aqueous media 47
4.2.2 Synthesis in non-aqueous media 47
4.2.3 Coordinating solvent synthesis 48
4.2.4 Synthesis in non-coordinating solvent 49
4.3 Formation mechanism 50
4.4 Different ways to synthesis InP 52

4.4.1 Synthesis InP in coordinating solvents ... 52
4.5 Synthesis InP in non-coordinating solvents with $P(TMS)_3$ ... 54
4.6 Synthesis InP with P(NMe2)3 ... 56
5 Controlling the shape of nanocrystals ... 58
6 The limits of use InP ... 58
7 Doping ... 60
8 Shell/core structures ... 62
9 Titanium dioxide TiO2 ... 65
9.1 General introduction of TiO2 ... 65
9.2 TiO2 as promising substrate for InP QDs: photoelectrochemical measurement ... 67
Conclusion ... 70
References ... 71
CHAPTER II ... 82
Synthesis methods and characterization techniques ... 82
1 Experimental work ... 83
1.1 Synthesis of QDs ... 83
1.2 Organometallic synthesis: hot injection or heat-up ... 83
1.3 Hot injection synthesis of InP QDs ... 84
1.4 Hot injection synthesis of InP QDs doped with Vanadium ... 86
1.5 Hot injection synthesis of core/shell InP/ZnS QDs and core/shell/shell InP/ZnS/ZnS QDS 86
1.6 Purification and Storage ... 87
1.7 Synthesis of titanium dioxide nanotubes by anodization method ... 88
1.8 Deposition of the nanostructured films of TiO2/InP, TiO2/InP/ZnS and TiO2/InP/ZnS/ZnS by spin coating method. ... 90
1.9 Photoelectrochemical activity ... 91
2 Analysis technique ... 92
2.1 X-Ray Diffraction (XRD) ... 92
2.2 Transmission Electron Microscopy (TEM) ... 95
2.3 Scanning Electron Microscope ... 97
2.4 Energy-dispersive Spectroscopy (EDS) ... 99
2.5 Photo-electrochemistry analysis ... 99
2.6 UV spectroscopy ... 101
2.6.1 Determination of the gap value ... 103
2.6.2 Transmission mode (direct method) ... 104
2.6.3 Photoluminescence ... 104

2.6.4 Spectroscopy of fluorescence ... 107
2.7 Numerical Analysis ... 107
2.7.1 Presentation of SCAPS-1D ... 108
2.7.2 Basic concepts ... 108
2.7.3 Definition of the problem ... 110
2.7.4 Adding layers to structure ... 110
Conclusion ... 112
References ... 113
CHAPTER III ... 124
InP Quantum Dots synthesis : photoluminescence enhancement strategies ... 124
Introduction ... 125
1 Effect of Vanadium doping on InP QDs ... 126
1.1 Study of structural properties: X-ray diffraction (XRD) ... 126
1.2 Study of morphological properties ... 127
1.3 Study of optical properties ... 130
1.3.1 Study of the doping vanadium effect on InP QDs photoluminescence ... 130
1.3.2 Study of redispersion method on InP QDs photoluminescence ... 132
1.3.3 Study of the doping vanadium effect on InP QDs absorption properties ... 135
2 Effect growth of InP/ZnS and InP/ZnS/ZnS Quantum Dots ... 138
2.1 X-ray diffraction (XRD) ... 138
2.2 Morphological properties of the particles by TEM ... 139
2.3 Analyse par spectroscopie UV-V visible ... 141
Conclusion ... 148
References ... 149
CHAPTER IV ... 160
TiO2/QDs for photoelectrochemical measurement: experimental and simulation study ... 160
Introduction ... 161
1 Characterization of TiO_2, TiO_2/InP, TiO_2/InP/ZnS and TiO_2/InP/ZnS/ZnS Quantum Dots nanostructures ... 161
1.1 Structural characterization ... 161
1.2 Morphological characterization ... 162
1.3 Photoelectrochemical Performance ... 166
2 Numerical Analysis ... 168
2.1 Definition of simulation ... 168
2.2 Fundamental equations ... 169
2.3 Basic modeling equations ... 169

2.4 Description and structure of device 170
Conclusion 174
References 175
CHAPTER V 186
General conclusion and outlook 186
Conclusion 187
Annexes 189