

# TABLE OF CONTENTS

---

## Table of contents

Abbreviations.....	xiii
Symbols.....	xiv
Preface.....	xv
1. Chapter 1.....	1
1.1 Self-assembly.....	4
1.1.1 Classification of self-assembled structures.....	4
1.1.1.1 Static/Equilibrium self-assembly (SSA).....	5
1.1.1.2 Dynamic/non-equilibrium self-assembly (DySA).....	5
1.1.2 Applications of SA in nanoarchitectonics.....	7
1.2 Metamaterials (MM).....	8
1.3 Self-assembled materials Vs Metamaterials.....	10
1.4 Theory of phase separation.....	11
1.4.1 Chemical phase separation.....	11
1.4.1.1 Spinodal decomposition.....	12
1.4.1.2 Nucleation and growth.....	14
1.4.1.3 Pseudospinodal decomposition.....	14
1.4.2 Order-disorder transformation.....	15
1.4.2.1 Charge ordering (CO).....	17
1.4.2.2 Magnetic ordering (MO).....	17
1.4.3 Structural phase separation.....	18
1.4.4 Electronic phase separation.....	19
1.5 History of self-assembled CB microstructures.....	20
1.5.1 Proposed theory for self-assembled 3D chessboard microstructures.....	20
1.5.1.1 Tweed-like structure to CB-like microstructure.....	21
1.5.1.2 J-T distortion assisted CB-like microstructural evolution.....	23
1.5.1.3 Order-disorder assisted CB-like microstructure.....	24
1.5.1.4 Octahedra tilting assisted CB-like microstructure.....	26
1.5.1.5 CB-like arrangements by pseudouniform ordering in superspace.....	27
1.6 Applications of CB-like microstructure.....	31
1.6.1 High density memory applications.....	31
1.6.2 Thermoelectric applications.....	33
1.6.3 Applications of self-assembled 3D CB microstructure in ASSLBs.....	33
References.....	36
2. Chapter 2.....	47
2.1 Material selection.....	48
2.2 Material synthesis.....	48
2.2.1 Synthesis of CB-like microstructure in spinel manganites.....	49

## TABLE OF CONTENTS

---

2.2.2	Synthesis of CB-like microstructure in $\text{Li}_{3x}\text{Nd}_{(2/3-x)}\square_{(1/3)-2x}\text{TiO}_3$ .....	50
2.3	Characterization techniques.....	50
2.3.1	XRD analysis.....	51
2.3.2	TEM analysis.....	51
2.3.3	APT analysis.....	52
2.4	Sample Preparation.....	54
2.4.1	XRD sample preparation.....	54
2.4.2	TEM sample preparation.....	54
2.4.3	APT sample preparation.....	54
2.5	Physical properties characterization.....	55
	References.....	57
3.	Chapter 3.....	59
3.1	Introduction.....	60
3.2	Materials and methods.....	61
3.3	Results and discussion.....	62
3.3.1	X-ray diffraction analysis.....	62
3.3.2	Diffraction contrast and Z-contrast imaging.....	64
3.3.3	Phase contrast imaging.....	75
3.4	Conclusions.....	78
	References.....	80
4.	Chapter 4.....	83
4.1	Introduction.....	84
4.2	Materials and methods.....	85
4.3	Results and discussion.....	86
4.3.1	X-ray diffraction analysis.....	86
4.3.2	Diffraction contrast imaging and Z-contrast imaging.....	88
4.3.3	Orientation relationship establishment.....	90
4.3.4	Observation of subdomains, their orientation relationship and chemistry.....	95
4.3.5	Clarification of CB-like appearance in 3D.....	97
4.3.6	Reconstruction of 3D microstructure via correlative microscopy.....	98
4.4	Conclusions.....	104
	References.....	105
5.	Chapter 5.....	109
5.1	Introduction.....	110
5.2	Materials and methods.....	113
5.3	Result and discussion.....	115
5.3.1	Microstructural characterization.....	115
5.3.1.1	XRD analysis.....	115
5.3.1.2	TEM analysis.....	119
5.3.1.3	3D re-construction of microstructure by APT.....	122

## TABLE OF CONTENTS

---

5.3.2	Effect of CB-like microstructural evolution on Electrochemical properties.....	124
5.4	Conclusions.....	127
	References.....	129
6.	Chapter 6.....	131
6.1	Introduction.....	132
6.2	Materials and methods.....	135
6.3	Results and discussion.....	136
6.3.1	XRD analysis.....	136
6.3.2	Diffraction contrast microscopy.....	138
6.4	Conclusions.....	145
	References.....	147
7.	Chapter 7.....	149
7.1	Conclusions.....	150
7.2	Scope and suggestion for future work.....	153
8.	List of publications.....	155
9.	List of conference presentations.....	156