

Table of Contents

CHAPTER 1 Introduction.....	11
1.1 Climate Change and Global Warming.....	13
1.1.1 Climate change.....	13
1.1.2 Evidence of greenhouse effect.....	16
1.1.3 International agreements.....	17
1.2 CO ₂ as the Inert Molecule.....	19
1.3 CO ₂ Hydrogenation.....	21
1.3.1 CO ₂ hydrogenation to methane.....	23
1.3.2 CO ₂ hydrogenation to methanol.....	23
1.3.3 CO ₂ hydrogenation to C ₂₊ hydrocarbons.....	27
1.4 Catalysts for CO ₂ Hydrogenation.....	29
1.4.1 Catalysts for CO ₂ hydrogenation to methane.....	31
1.4.2 Catalysts for CO ₂ hydrogenation to methanol.....	31
1.4.3 Catalysts for CO ₂ hydrogenation to C ₂₊ hydrocarbons.....	33
1.4.4 Influence of supports.....	34
1.4.5 Effect of metal particle size.....	44
1.4.6 Influence of promoters and poisons.....	45
CHAPTER 2 Objectives.....	61
CHAPTER 3 Co-Fe Nanoparticles Wrapped on N-Doped Graphitic Carbons as Highly Efficient CO₂ Methanation Catalysts.....	67
3.1 Introduction.....	69
3.2 Results and Discussion.....	69
3.2.1 Samples Preparation and Characterization.....	69

3.2.2 Catalytic Activity.....	78
3.2.3 Influence of the Support.....	82
3.3 Conclusions.....	83

CHAPTER 4 Co-Fe Clusters Supported on N-Doped Graphitic Carbon as Highly Selective Catalysts for Reverse Water-Gas Shift Reaction.....87

4.1 Introduction.....	89
4.2 Results and Discussion.....	89
4.2.1 Samples preparation and characterization.....	89
4.2.2 Catalytic activity.....	103
4.2.3 Influence of the metal alloy.....	107
4.2.4 Influence of the support.....	108
4.3 Conclusions.....	109

CHAPTER 5 Particle Size Control of Co-Fe Nanoparticles Wrapped on Defective N-doped Graphitic Carbons as Efficient Catalysts for High Selectivity of C₂-C₄ Hydrocarbons in CO₂ Hydrogenation.....113

5.1 Introduction.....	115
5.2 Results and Discussion.....	116
5.2.1 Samples preparation and characterization.....	116
5.2.2 Catalytic activity.....	123
5.2.3 Stability study.....	127
5.2.4 Influence of H ₂ /CO ₂ ratios.....	128
5.2.5 Influence of reaction pressure.....	130
5.3 Conclusions.....	135

CHAPTER 6 Promotional Effects on the Catalytic Activity of Co-Fe Alloy

Supported on Graphitic Carbons for CO₂ Hydrogenation.....	143
6.1 Introduction.....	145
6.2 Results and Discussion.....	145
6.2.1 Samples preparation and characterization.....	145
6.2.2 Catalytic activity.....	157
6.3 Conclusions.....	164
CHAPTER 7 Cu-ZnO Clusters Supported on N-Doped Graphitic Carbons as Highly Selective Catalysts for CO₂ Conversion to Methanol.....	171
7.1 Introduction.....	173
7.2 Results and Discussion.....	173
7.2.1 Samples preparation and characterization.....	173
7.2.2 Catalytic activity.....	179
7.3 Conclusions.....	181
CHAPTER 8 Experimental Section.....	185
8.1 General Procedures.....	187
8.1.1 Synthesis of samples Co@(N)C, Co-Fe@(N)C and Co-Fe@TiO ₂ prepared in CHAPTER 3	187
8.1.2 Synthesis of samples Co-Fe@(N)C, Co@(N)C, Fe@(N)C, Co-Fe@C and Co-Fe@SiO ₂ prepared in CHAPTER 4	189
8.1.3 Synthesis of the Co-Fe@(N)C samples prepared in CHAPTER 5 . 191	
8.1.4 Synthesis of samples Co-Fe@(N)C and Co-Fe@C prepared in CHAPTER 6	193
8.1.5 Synthesis of samples Cu@(N)C and Cu-ZnO@C prepared in CHAPTER 7	196
8.2 Sample Characterization.....	197

8.3 Catalytic Tests.....	198
8.4 Tables of Catalytic Activity and Selectivity.....	200
8.4.1 Tables of catalytic activity and selectivity for methane in CHAPTER 3	200
8.4.2 Tables of catalytic activity and selectivity for carbon monoxide in CHAPTER 4	203
8.4.3 Tables of catalytic activity and selectivity for C ₂ -C ₄ hydrocarbons in CHAPTER 5	208
8.4.4 Tables of catalytic activity and selectivity for C ₂ -C ₄ hydrocarbons with promoters and poison in CHAPTER 6	219
8.4.5 Tables of catalytic activity and selectivity for methanol in CHAPTER 7	225
CHAPTER 9 Conclusions	229
Abstract	233
List of Publications	239