
General Introduction	1-36
Chapter 1: Synthesis & Characterization of SiW_{11} as well as SiW_{11} Anchored to MCM-41 ($\text{SiW}_{11}/\text{MCM-41}$)	37-70
Introduction	38-90
Experimental	40-50
➤ Materials	
➤ Synthesis of the support (MCM-41)	
➤ Synthesis of monolacunary silicotungstate, SiW_{11}	
Synthesis of the catalyst	
➤ Synthesis of $\text{SiW}_{11}/\text{MCM-41}$	
Results and Discussion	
Characterization of SiW_{11}	51-55
➤ Elemental Analysis	
➤ Thermal Analysis	
➤ Fourier Transform Infrared Spectroscopy	
➤ Laser Raman Spectroscopy	
➤ ^{29}Si MAS- NMR studies	
Characterization of $\text{SiW}_{11}/\text{MCM-41}$	55-67
➤ Leaching Test	
➤ Elemental analysis	
➤ Thermal Analysis	
➤ BET surface area	
➤ Fourier Transform Infrared Spectroscopy	
➤ Laser Raman Spectroscopy	
➤ ^{29}Si MAS- NMR studies	
➤ X-ray diffraction	
➤ Scanning Electron Microscopy	
➤ Transmission Electron Microscopy	
➤ Acidity measurements	
Conclusion	68
References	69-70

Chapter 2: Catalytic Activity of SiW₁₂/SiW₁₁ Anchored to MCM-41,	71-147
Chapter 2A. Biodiesel Synthesis via Esterification of Oleic acid and	72-120
<i>Transesterification of Soybean oil.</i>	
Introduction	73-85
Experimental	86-87
➤ Materials	
➤ Reaction Procedure	
Results and Discussion	
(I) Esterification of oleic acid with methanol	87-98
➤ Effect of % loading of SiW ₁₁	
➤ Effect of mole ratio of acid to alcohol	
➤ Effect of amount of catalyst	
➤ Effect of reaction time	
➤ Effect of reaction temperature	
➤ Control experiments for esterification of oleic acid	
➤ Heterogeneity test	
➤ Regeneration and recycling of the catalyst	
➤ Kinetic study	
(II) Transesterification of triglycerides (Soybean oil)	99-112
➤ Effect of % loading of SiW ₁₂ /SiW ₁₁	
➤ Effect of wt. ratio of oil to alcohol	
➤ Effect of amount of catalyst	
➤ Effect of reaction time	
➤ Effect of reaction temperature	
➤ Control experiments	
➤ Heterogeneity test	
➤ Regeneration and recycling of the catalyst	
➤ Characterization of biodiesel derived from transesterification of soybean oil	
➤ Properties of biodiesel produced	
Mechanism of esterification – transesterification reaction	112-113
Conclusion	114
References	115-120

Chapter 2B. Valorisation of glycerol via acetalization with benzaldehyde and carboxylation with urea.	121-147
Introduction	122-126
Experimental	127
➤ Materials	
➤ Reaction Procedure	
Results and Discussion	
I) Acetalization of glycerol with benzaldehyde	128-134
➤ Effect of % loading of SiW ₁₂ /SiW ₁₁	
➤ Effect of mole ratio of glycerol to benzaldehyde	
➤ Effect of amount of catalyst	
➤ Effect of reaction time	
➤ Control experiments	
➤ Regeneration and recycling of the catalyst	
II) Carboxylation of glycerol with urea	135-142
➤ Effect of % loading of SiW ₁₂ /SiW ₁₁	
➤ Effect of mole ratio of glycerol to urea	
➤ Effect of amount of the catalyst	
➤ Effect of reaction time	
➤ Effect of reaction temperature	
➤ Control experiments	
➤ Heterogeneity test	
➤ Regeneration and recycling of the catalyst	
Mechanism for acetalization as well as carboxylation of glycerol	142-143
Conclusion	144
References	145-147
Chapter 3: Synthesis & Characterization of, SiW₁₂ anchored to Hβ (SiW₁₂/Hβ) & SiW₁₁ anchored to zeolite Hβ (SiW₁₁/Hβ)	148-172
Introduction	149-154
Experimental	155-156
Synthesis of the catalysts	

Results and Discussion	157-169
Characterization of SiW₁₂/SiW₁₁ anchored to Hβ	
➤ Leaching Test	
➤ Elemental analysis	
➤ Thermal Analysis	
➤ BET surface area	
➤ Fourier Transform Infrared Spectroscopy	
➤ Laser Raman Spectroscopy	
➤ ²⁹ Si MAS- NMR studies	
➤ X-ray diffraction	
➤ Scanning Electron Microscopy	
➤ Transmission Electron Microscopy	
➤ Acidity measurements	
Conclusion	170
References	171-172
Chapter 4: Catalytic Activity of SiW₁₂/SiW₁₁ Anchored to Hβ,	173-218
Chapter 4A. Biodiesel Synthesis via Esterification of Oleic acid and Transesterification of Soybean oil.	174-198
Introduction	175
Experimental	175-176
Results and Discussion	177-195
<i>(I) Esterification of oleic acid with methanol</i>	
<i>(II) Transesterification of triglycerides (Soybean oil)</i>	
Possible Industrial Scheme for Biodiesel Production	196
Conclusion	197
References	198
Chapter 4B. Valorisation of glycerol via acetalization with benzaldehyde and carboxylation with urea.	199-218
Introduction	199
Experimental	200

Results and Discussion	201-216
<i>I) Acetalization of glycerol with benzaldehyde</i>	
<i>II) Carboxylation of glycerol with urea</i>	
Conclusion	217
References	218
Appendix: Comparison of activity of the synthesized catalysts	219-226
Main conclusion	227
Novelty of the work	228
