



Ain Shams University  
Faculty of Science  
Chemistry Department

# **New Trends for Preparing Mesoporous Catalysts to Produce Green Fuel**

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## **New Trends for Preparing Mesoporous Catalysts to Produce Green Fuel**

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# ***DEDICATION***

*I dedicate my dissertation work to my family.  
A special feeling of gratitude to my loving father,  
my mother, sisters and brothers.*

*I also dedicate this dissertation to my husband  
Mohamed for continuous support, encouragement  
and generous help throughout the progress of this  
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## Abstract

The present study was undertaken to synthesize new composite systems consisted of  $\text{F}_2\text{O}_3$  NPs (5 wt %) loaded on neat SBA-15, Al-modified SBA-15 and Zr-modified SBA-15 supports. The loading process was displayed by adopting microwave-assisted or ultrasonic-assisted routes. Various modification techniques of SBA-15, characterized by its well-ordered hexagonal arrays of mesopores, with 25 wt % of Al or Zr (the confirmed optimum ratio) included the following methods: impregnation post synthesis (Al or Zr-S (Imp)), ultrasonic post synthesis (Al or Zr-S(Us)) and in situ direct synthesis (Al or Zr-S(Inst)). The as-synthesized catalytic systems were characterized adopting several techniques, viz.,  $\text{N}_2$  adsorption–desorption, XRF, XRD, TGA–DSC, FT-IR, TEM, EDX,  $\text{H}_2$ -TPR and  $\text{NH}_3$ -TPD. All the synthesized catalyst samples were examined in three different applications, namely, catalytic conversion of ethanol and methanol as two model compounds using micro pulse and continuous flow systems. In addition, the photocatalytic water splitting reaction was applied for hydrogen generation/storage under visible light irradiation. The results revealed that the applied modifications of the mother SBA-15, after incorporation of Al or Zr led to marked increase in the surface parameters as well as the acidity referred mainly to the presence of the favourable moderate Brønsted acid sites. The obtained results showed that all the studied catalytic systems are rather suitable for  $\text{H}_2$  storage with maximum capacity. This was interpreted in view of the fitting modifications in the pore system and the whole structure profile of

the catalyst samples used. The catalytic systems synthesized through ultrasonic-assisted route showed more prevailing behavior in the photocatalytic splitting process. Moreover, these catalysts exhibited the highest activity towards ethylene production, with a distinct increase in their yield and selectivity compared with those samples prepared by microwave assisted technique. Such behaviour was referred to the higher surface area, the change in the pore geometry (bimodal PSD) and the good dispersion mode beside the improvement in the whole texture properties. On the other hand, the yield and the selectivity of dimethyl ether over Fe(M)/Zr-S(Imp) were higher than those of Fe(Us)/Zr-S(Imp) to be 100 and 84.80% at 200° C, respectively. From the formation results obtained in this study, it could be suggested that the as-synthesized nanocomposites are promising candidates for green fuel production, in terms of H<sub>2</sub> storage materials through water splitting under visible light irradiation, methanol dehydration into dimethyl ether as alternative fuel, as well as ethanol dehydration into ethylene as a starting material for petrochemical industries.

**Keywords:** Fe/Al-SBA-15, Fe/Zr-SBA-15, Microwave and Ultrasonic assisted synthesis routes, H<sub>2</sub>-Storage, Water Splitting, Ethanol and methanol conversions.

# CONTENTS

	<b>Acknowledgement</b>	
	<b>Abstract</b>	<b>i</b>
	<b>Content</b>	<b>I</b>
	<b>List of Figures</b>	<b>IX</b>
	<b>List of Tables</b>	<b>XVIII</b>
	<b>List of Abbreviation</b>	<b>XXI</b>
	<b>Aim of Work</b>	<b>XXV</b>
	 <b>CHAPTER (I)</b>	
<b>1.</b>	<b>INTRODUCTION</b>	<b>1</b>
<b>1.1.</b>	<b>Modified Heterogeneous Catalysts</b>	<b>1</b>
<b>1.2.</b>	<b>Mesoporous structured Materials</b>	<b>2</b>
<b>1.3.</b>	<b>Ordered Mesoporous Materials</b>	<b>3</b>
<b>1.4.</b>	<b>Ordered Mesoporous SBA-15</b>	<b>6</b>
<b>1.5.</b>	<b>Alumina-SBA-15</b>	<b>15</b>
<b>1.6.</b>	<b>Functionalization of SBA-15</b>	<b>22</b>
<b>1.7.</b>	<b>Main SBA-15 functionalization methods</b>	<b>23</b>
<b>1.7.1.</b>	<b>Direct synthesis method</b>	<b>23</b>
<b>1.7.2.</b>	<b>Post-synthesis or post-grafting method</b>	<b>24</b>
<b>1.7.3.</b>	<b>Deposition–precipitation (DP) method</b>	<b>26</b>
<b>1.7.4.</b>	<b>Graft hybrid (GH) method</b>	<b>28</b>
<b>1.7.5.</b>	<b>Colloid immobilization method</b>	<b>29</b>
<b>1.7.6.</b>	<b>Nanoparticle encapsulation method</b>	<b>30</b>

<b>1.8.</b>	<b>Ultrasonic-Assisted Impregnation</b>	<b>31</b>
<b>1.8.1.</b>	<b>Mechanism of sonication</b>	<b>32</b>
<b>1.9.</b>	<b>Microwave –Assisted Technique</b>	<b>36</b>
<b>1.9.1.</b>	<b>Reaction mechanism of microwave heating</b>	<b>38</b>
<b>1.10.</b>	<b>Iron</b>	<b>45</b>
<b>1.11.</b>	<b>Zirconium</b>	<b>48</b>
<b>1.12.</b>	<b>Energy Challenge and Green fuels</b>	<b>50</b>
<b>1.12.1.</b>	<b>Catalytic conversion of methanol into di methyl ether (DME) as a green fuel</b>	<b>51</b>
<b>1.12.2.</b>	<b>Hydrogen as a green fuel</b>	<b>55</b>
<b>1.12.2.1.</b>	<b>Water splitting</b>	<b>57</b>
<b>1.12.2.2.</b>	<b>Metal Oxide Semiconductors</b>	<b>60</b>
<b>1.13</b>	<b>Catalytic Conversion of Ethanol into Ethylene and Acetaldehyde</b>	<b>65</b>
 <b>CHAPTER II</b>		
<b>2.</b>	<b>EXPERIMENTAL</b>	<b>70</b>
<b>2.1.</b>	<b>Materials</b>	<b>70</b>
<b>2.2.</b>	<b>Preparation of SBA-15 by hydrothermal method</b>	<b>70</b>
<b>2.2.1.</b>	<b>Synthesis of Al-SBA-15 via direct synthesis</b>	<b>71</b>
<b>2.2.2.</b>	<b>Synthesis of Al-SBA-15 by ultrasonic post synthesis method</b>	<b>71</b>
<b>2.2.3.</b>	<b>Synthesis of Al/SBA-15 by impregnation post synthesis method</b>	<b>72</b>



<b>2.2.4.</b>	<b>Loading of 5% Fe on 25% Al-SBA-15 via the microwave assisted solution radiation (M) route</b>	<b>73</b>
<b>2.2.5.</b>	<b>Loading of 5% Fe on 25% Al-SBA-15 via the ultrasonic post synthesis (U) route</b>	<b>74</b>
<b>2.2.6.</b>	<b>Synthesis of 25% Zr/ SBA-15 via direct synthesis</b>	<b>75</b>
<b>2.2.7.</b>	<b>Synthesis of 25 % Zr/SBA-15 by ultrasonic post synthesis method.</b>	<b>75</b>
<b>2.2.8.</b>	<b>Synthesis of 25% Zr/SBA-15 by impregnation post synthesis method</b>	<b>76</b>
<b>2.3.</b>	<b>Catalyst characterization</b>	<b>76</b>
<b>2.3.1.</b>	<b>X-ray fluroscence (XRF) analysis</b>	<b>76</b>
<b>2.3.2.</b>	<b>Surface area measurement</b>	<b>76</b>
<b>2.3.3.</b>	<b>X-ray diffraction analysis (XRD)</b>	<b>77</b>
<b>2.3.4.</b>	<b>Fourier-Transform Infrared( FT-IR) analysis</b>	<b>77</b>
<b>2.3.5.</b>	<b>Transmission Electron Microscopy (TEM) analysis</b>	<b>78</b>
<b>2.3.6.</b>	<b>Thermal Gravimetric analysis (DSC-TGA)</b>	<b>78</b>
<b>2.3.7.</b>	<b>Temperature Programmed Desorption of Ammonia (NH<sub>3</sub>-TPD) analysis</b>	<b>78</b>
<b>2.3.8.</b>	<b>Temperature Programmed Reduction (TPR)</b>	<b>79</b>
<b>2.3.9.</b>	<b>Pulse titration (H<sub>2</sub>-Chemisorption) for estimation of metal dispersion parameters</b>	<b>79</b>
<b>2.3.10.</b>	<b>The absorptivity of the semiconductors</b>	<b>80</b>
<b>2.4.</b>	<b>Catalytic Activity Measurements</b>	<b>80</b>

<b>2.4.1.</b>	<b>Continuous flow system</b>	<b>80</b>
<b>2.4.2.</b>	<b>Water Splitting</b>	<b>82</b>
<b>2.4.3.</b>	<b>Online pulse-reaction chromatography</b>	<b>83</b>
 <b>CHAPTER III</b>		
	<b>RESULTS and DISCUSSION</b>	<b>85</b>
	<b>Characterization of different catalytic systems under study</b>	<b>85</b>
<b>3.1.</b>	<b>Optimization of Al ratio for modification of SBA-15 by applying different techniques</b>	<b>85</b>
<b>3.1.1.</b>	<b>From N<sub>2</sub>-physisorption study on different Al-modified SBA-15 samples</b>	<b>85</b>
<b>3.1.1.1.</b>	<b>N<sub>2</sub>-physisorption results on neat SBA-15 and Al-modified SBA-15 with different Al ratios via one-pot in situ method</b>	<b>85</b>
<b>3.1.1.2.</b>	<b>N<sub>2</sub> physisorption results on Al-modified SBA-15 with different Al ratios via ultrasonic post method</b>	<b>88</b>
<b>3.1.1.3.</b>	<b>N<sub>2</sub> physisorption on Al-modified SBA-15 with different ratios via Impregnation post method</b>	<b>90</b>
<b>3.1.2.</b>	<b>From NH<sub>3</sub>-TPD study on different Al-modified SBA-15 samples</b>	<b>92</b>
<b>3.1.2.1.</b>	<b>NH<sub>3</sub>-TPD profiles for neat SBA-15 and Al-modified SBA-15 with different Al ratios via one-pot direct synthesis route</b>	<b>92</b>

<b>3.1.2.2.</b>	<b>NH<sub>3</sub>-TPD profiles for Al-modified SBA-15 with different Al ratios via ultrasonic post method</b>	<b>95</b>
<b>3.1.2.3.</b>	<b>NH<sub>3</sub>-TPD profiles for Al-modified SBA-15 with different Al ratios via impregnation post method</b>	<b>96</b>
<b>3.2.</b>	<b>Physicochemical characteristics of neat SBA-15 and 25 % Al-modified SBA-15 systems synthesized by different routes</b>	<b>99</b>
<b>3.2.1.</b>	<b>XRF investigation</b>	<b>99</b>
<b>3.2.2.</b>	<b>Surface characteristics of neat SBA-15 and various 25 wt Al modified SBA-15 catalyst samples</b>	<b>100</b>
<b>3.2.3.</b>	<b>XRD analysis</b>	<b>102</b>
<b>3.2.4.</b>	<b>FTIR analysis</b>	<b>104</b>
<b>3..5.</b>	<b>TEM investigation</b>	<b>106</b>
<b>3.2.6.</b>	<b>DSC-TGA analysis</b>	<b>108</b>
<b>3.2.7.</b>	<b>NH<sub>3</sub>-TPD profiles</b>	<b>109</b>
<b>3.3.</b>	<b>Characterization of 5 % Fe<sub>2</sub>O<sub>3</sub> loaded SBA-15 and 5 % Fe-Loaded 25 % Al-SBA-15 catalysts</b>	<b>111</b>
<b>3.3.1.</b>	<b>XRF analysis</b>	<b>111</b>
<b>3.3.2.</b>	<b>Surface characteristics</b>	<b>112</b>
<b>3.3.2.1.</b>	<b>Pore size distribution (PSD) models</b>	<b>115</b>
<b>3.3.3.</b>	<b>XRD analysis</b>	<b>118</b>
<b>3.3.4.</b>	<b>FTIR invesigation</b>	<b>118</b>
<b>3.3.5</b>	<b>TEM invesigation</b>	<b>120</b>
<b>3.3.6</b>	<b>NH<sub>3</sub>-TPD profiles</b>	<b>125</b>

<b>3.3.7.</b>	<b>H<sub>2</sub>-TPR trends</b>	<b>128</b>
<b>(i)</b>	<b>H<sub>2</sub>-TPR profiles</b>	<b>128</b>
<b>(ii)</b>	<b>Fe- surface dispersion modes from H<sub>2</sub> - Chemisorption</b>	<b>130</b>
<b>3.4.</b>	<b>Characterization of Zirconia-modified SBA-15 Catalytic systems (Zr-SBA-15)</b>	<b>132</b>
<b>3.4.1.</b>	<b>Surface characteristics</b>	<b>132</b>
<b>3.4.2.</b>	<b>XRD analysis</b>	<b>134</b>
<b>3.4.3.</b>	<b>FTIR analysis</b>	<b>136</b>
<b>3.4.4.</b>	<b>Thermal (TGA and DSC) analysis</b>	<b>137</b>
<b>3.4.5.</b>	<b>TEM investigation</b>	<b>138</b>
<b>3.4.6.</b>	<b>NH<sub>3</sub> –TPD profiles.</b>	<b>140</b>
<b>3.5.</b>	<b>Characterization of (5 wt %) iron loaded on Zr- S(Imp) via microwave and ultrasonic methods</b>	<b>142</b>
<b>3.5.1.</b>	<b>Surface characteristics</b>	<b>142</b>
<b>3.5.2.</b>	<b>XRD analysis</b>	<b>144</b>
<b>3.5.3.</b>	<b>FTIR investigation</b>	<b>145</b>
<b>3.5.4.</b>	<b>Thermal (TGA and DSC) analysis</b>	<b>146</b>
<b>3.5.5.</b>	<b>TEM investigation</b>	<b>148</b>
<b>3.5.6.</b>	<b>NH<sub>3</sub> -TPD study</b>	<b>149</b>
<b>3.6.</b>	<b>Catalytic performance of synthesized systems under study</b>	<b>151</b>
<b>3.6.1.</b>	<b>Catalytic Conversion of Methanol over synthesized catalytic systems under study</b>	<b>151</b>
<b>3.6.1.1.</b>	<b>Catalytic conversion of methanol over SBA-15, Fe (M)/S and Fe(U)/S</b>	<b>152</b>

<b>3.6.1.2.</b>	<b>Catalytic conversion of mehanol over Fe/Al-modified SBA-15 by using different methods.</b>	<b>156</b>
<b>3.6.1.2.1.</b>	<b>Catalytic conversion of methanol over Al-modified-S(Inst), Fe (M)/Al-S(Inst) and Fe(U)/Al-S(Inst).</b>	<b>156</b>
<b>3.6.1.2.2.</b>	<b>Catalytic conversion of methanol over Al-modified-S(Us), Fe(M)/Al-S(Us) and Fe(U)/Al-S(Us).</b>	<b>162</b>
<b>3.6.1.2.3.</b>	<b>Catalytic conversion of methanol over Al modified-S(Imp), Fe(M)/Al-S(Imp) and Fe(U)/Al-S(Imp) samples.</b>	<b>166</b>
<b>3.6.1.3.</b>	<b>The catalytic conversion of methanol over zirconium modified catalysts and iron loaded on Zr-S(Imp) via microwave and ultrasonic methods</b>	<b>171</b>
<b>3.6.2.</b>	<b>Photocatalytic performance of the synthesized catalytic systems under study</b>	<b>178</b>
<b>3.6.2.1.</b>	<b>Mechanism of photocatalytic water splitting</b>	<b>178</b>
<b>3.6.2.2.</b>	<b>UV absorbance and energy band gaps</b>	<b>179</b>
<b>3.6.2.3.</b>	<b>Photocatalytic performance profiles in water splitting versus pore structure behaviour</b>	<b>185</b>
<b>3.6.3.</b>	<b>Catalytic performance in enhancing ethylene production through ethanol dehydration</b>	<b>189</b>
<b>3.6.3.1.</b>	<b>Catalytic conversion of ethanol over SBA-15 and Al-modified SBA-15 catalysts</b>	<b>189</b>

<b>3.6.3.2.</b>	<b>Catalytic conversion of ethanol over Fe loaded on SBA-15 and Al-modified SBA-15 via microwave and ultrasonic assisted routes</b>	<b>196</b>
<b>3.6.3.2.1.</b>	<b>The catalytic conversion of ethanol over Fe loaded on SBA-15 and Al-modified SBA-15 via microwave assisted route</b>	<b>196</b>
<b>3.6.3.2.2.</b>	<b>Catalytic conversion of ethanol over Fe loaded via ultrasonic-assisted route on SBA-15 and different Al-modified SBA-15</b>	<b>202</b>
	<b>SUMMARY</b>	<b>208</b>
	<b>References</b>	<b>216</b>
	<b>Arabic summary</b>	

## List of Figures

<b>Fig. 1</b>	<b>Pore models of mesostructures of (A) p6 mm, (B) Ia3d, (C) Pm3n, (D) Im3m, (E) Fd3m and (F) Fm3m.</b>	<b>5</b>
<b>Fig. 2</b>	<b>Hydrolysis of silica source.</b>	<b>7</b>
<b>Fig. 3</b>	<b>Silica network (1): alcohol condensation.</b>	<b>8</b>
<b>Fig. 4</b>	<b>Silica network (2): water condensation.</b>	<b>8</b>
<b>Fig. 5</b>	<b><math>S^0H^+X^-I^+</math> interaction.</b>	<b>9</b>
<b>Fig. 6</b>	<b>Schematic representation of SBA-15 before calcination.</b>	<b>10</b>
<b>Fig. 7</b>	<b>Schematic representation of SBA-15 after calcination.</b>	<b>11</b>
<b>Fig. 8</b>	<b>Preparation of the Al-SBA-15 mesoporous materials with different morphologies.</b>	<b>19</b>
<b>Fig. 9</b>	<b>Preparation of Al@SBA-15 composites and Pt/Al@SBA-15 catalysts.</b>	<b>21</b>
<b>Fig. 10</b>	<b>Main steps of SBA-15 functionalization by direct synthesis method.</b>	<b>24</b>
<b>Fig. 11</b>	<b>Main steps of SBA-15 functionalization by post- synthesis method.</b>	<b>26</b>
<b>Fig. 12</b>	<b>Main steps of SBA-15 functionalization by deposition–precipitation (DP).</b>	<b>27</b>
<b>Fig. 13</b>	<b>Main steps of SBA-15 functionalization by graft hybrid (GH) methods.</b>	<b>28</b>