List of Figures:

Fig. 1.1 Schematic cross section of a porous solid 2
Fig. 1.2 Classification of nanoporous materials 4
Fig. 1.3 General Scheme for the self-assembly reaction of different surfactant and inorganic species 6
Fig. 1.4 Liquid Crystal Templating Method 6
Fig. 1.5 A. Cooperative self-assembly and B. "True" Liquid Crystal Templating Mechanism 7
Fig. 1.6 Silica hydrolysis and polymerization under acidic condition 8
Fig. 1.7 Hydrolysis and condensation of silica under alkaline conditions 9
Fig. 1.8 Tetraethyloxysilicate (TEOS) molecule 9
Fig. 1.9 Triblock P123 polymer molecule 10
Fig. 1.10 Post synthesis grafting of mesoporous silica 14
Fig. 1.11 Co-condensation (direct) method for the organic functionalization 14
Fig. 1.12 Formation of PMO 15
Fig. 1.13 Some molecules used for amine functionalization 15
Fig. 1.14 Nitrogen adsorption desorption isotherm of SBA-15 16
Fig. 1.15 Transmission Electron Micrograph of SBA-15 17
Fig. 1.16 Schematic representation of synthesis of Ag-mSBA-15 18
Fig. 1.17 Pore wall functionalization of silica mesopores and various drug molecules 19
Fig. 2.1 Relationship between symmetry and crystal structures 31
Fig. 2.2 Types of physisorption isotherms as classified by IUPAC 32
Fig. 2.3 Types of hysteresis 34
Fig. 2.4 Linear BET plot 36
Fig. 2.5 Harkins and Jura t-plot 39
Fig. 2.6 Schematic representation of an Electron Microscope 41
Fig. 2.7 The JEOL JEM 2100 Transmission Electron Microscope 42
Fig. 3.1 Low angle powder XRD patterns of calcined SBA-15 53
Fig. 3.2 Wide angle powder XRD patterns of SBA-15 53
<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fig. 3.3</td>
<td>N2 adsorption desorption isotherm of SBA-15</td>
<td>55</td>
</tr>
<tr>
<td>Fig. 3.4</td>
<td>BET plot of SBA-15</td>
<td>56</td>
</tr>
<tr>
<td>Fig. 3.5</td>
<td>t-plot of SBA-15 in thickness range 3.54-5 Å</td>
<td>56</td>
</tr>
<tr>
<td>Fig. 3.6</td>
<td>BJH pore size distribution plot calculated from adsorption branch</td>
<td>57</td>
</tr>
<tr>
<td>Fig. 3.7</td>
<td>BJH desorption pore size distribution</td>
<td>57</td>
</tr>
<tr>
<td>Fig. 3.8</td>
<td>Transmission electron micrographs of SBA-15; (a) ordered mesochannels of SBA-15, (b) hexagonal porous structure, (c) electron diffraction, (d) low magnification image showing SBA-15 particles.</td>
<td>59</td>
</tr>
<tr>
<td>Fig. 3.9</td>
<td>FT-IR spectrum of calcined SBA-15</td>
<td>60</td>
</tr>
<tr>
<td>Fig. 3.10</td>
<td>TGA plot of as synthesized SBA-15</td>
<td>61</td>
</tr>
<tr>
<td>Fig. 3.11</td>
<td>Molecular Structure of aspirin molecule</td>
<td>62</td>
</tr>
<tr>
<td>Fig. 3.12</td>
<td>Aspirin calibration curve</td>
<td>63</td>
</tr>
<tr>
<td>Fig. 3.13</td>
<td>FT-IR spectrum of aspirin loaded SBA-15</td>
<td>64</td>
</tr>
<tr>
<td>Fig. 3.14</td>
<td>Aspirin loading capacity of SBA-15 at different time interval</td>
<td>65</td>
</tr>
<tr>
<td>Fig. 3.15</td>
<td>Aspirin release profile</td>
<td>66</td>
</tr>
<tr>
<td>Fig. 4.1</td>
<td>Low angle powder X-Ray diffractogram of Pt-SBA-15</td>
<td>72</td>
</tr>
<tr>
<td>Fig. 4.2</td>
<td>Wide angle powder XRD patterns of Pt-SBA-15</td>
<td>73</td>
</tr>
<tr>
<td>Fig. 4.3</td>
<td>Nitrogen adsorption desorption isotherm of Pt-SBA-15</td>
<td>75</td>
</tr>
<tr>
<td>Fig. 4.4</td>
<td>BET plot of Pt-SBA-15</td>
<td>75</td>
</tr>
<tr>
<td>Fig. 4.5</td>
<td>Harkins-Jura thickness t-plot of Pt-SBA-15</td>
<td>76</td>
</tr>
<tr>
<td>Fig. 4.6</td>
<td>Pore size distribution of Pt-SBA-15 from the adsorption branch; inset-desorption branch</td>
<td>76</td>
</tr>
<tr>
<td>Fig. 4.7</td>
<td>Transmission Electron Micrographs of Pt-SBA-15; (a) hexagonal pore symmetry; (b) ordered mesoporous channels (c) SAED patterns showing diffraction;(d) Platinum loading in the ordered mesopore structures</td>
<td>78</td>
</tr>
<tr>
<td>Fig. 4.8</td>
<td>Scanning Electron Microscope images of Platinum loaded SBA-15</td>
<td>79</td>
</tr>
<tr>
<td>Fig. 4.9</td>
<td>UV-Visible spectra showing reduction of 4-nitrophenol in presence of Pt-SBA-15 catalyst by NaBH4</td>
<td>82</td>
</tr>
<tr>
<td>Fig. 4.10</td>
<td>Linear plot of ln(A0/An) versus time in presence of Pt-SBA-15 catalyst showing pseudo-first order kinetics according to Langmuir-Hinshelwood mechanism</td>
<td>82</td>
</tr>
</tbody>
</table>
Fig. 4.11 Time dependent UV-Visible spectra at different reaction times for the electron transfer reaction between hexacyanoferrate (III) and sodium thiosulfate in the presence of Pt-SBA-15 83

Fig. 4.12 Linear plot of ln(A0/At) vs time for the reaction between hexacyanoferrate (III) and sodium thiosulfate in presence of Pt-SBA-15 which follows pseudo-first order kinetics 84

Fig. 4.13 Low angle powder XRD patterns of Ni-SBA-15 86
Fig. 4.14 Wide angle powder XRD patterns of Nickel loaded SBA-15 86
Fig. 4.15 Nitrogen adsorption desorption isotherm of Ni-SBA-15 88

Fig. 4.16 Pore size distribution of Ni-SBA-15 of the adsorption branch; inset-desorption branch 88

Fig. 4.17 BET plot of Ni-SBA-15 89
Fig. 4.18 Representative t-plot of Ni-SBA-15 in the thickness range 3.5-5Å 89
Fig. 4.19 Transmission Electron Microscopy images of Ni-SBA-15 91
Fig. 4.20 UV-Visible spectra showing reduction of 4-NP 92
Fig. 4.21 Pseudo first order kinetics linear fit plot 93
Fig. 4.22 N2 adsorption-desorption isotherm of TiO2 loaded SBA-15 at -196 °C 95
Fig. 4.23 BET plot of TiO2-SBA-15 95
Fig. 4.24 Representative t-plot of TiO2-SBA-15 96

Fig. 4.25 Pore size distribution of (TiO2-SBA-15) from the adsorption branch; inset-desorption branch 96
Fig. 4.26 Low angle XRD pattern of TiO2 loaded SBA-15 97
Fig. 4.27 Wide angle powder XRD pattern of TiO2 loaded SBA-15 98
Fig. 4.28 Wide angle powder XRD pattern of pure TiO2 98
Fig. 4.29 Diffuse-reflectance UV-Visible spectrum of TiO2-SBA-15 99
Fig. 4.30 Structure of Rhodamine B 100
Fig. 4.31 De-ethylation of Rhodamine B 101
Fig. 4.32 Plot of absorbance vs time for UV light decomposition of Rhodamine B 102
Fig. 4.33 Linear fit pseudo-first order kinetics plot of decomposition of Rhodamine B 102
Fig. 4.34 Structure of Methylene Blue 103
Fig. 4.35 Photocatalytic decomposition of Methylene Blue 104
Fig. 4.36 Linear fit kinetics plot of Methylene blue decomposition

Fig. 4.37 UV-Visible spectra showing temporal formation of AgNP recorded at different time intervals

Fig. 4.38 Particle size distribution of green synthesized AgNP

Fig. 4.39 Transmission electron micrographs of Silver nano particles at different resolutions and Electron Diffraction patterns

Fig. 4.40 H. Sabdariffa plant (Roselle; Tengamora) showing leaves and calyces

Fig. 4.41 (a) H. Sabdariffa leaf extract and (b) the H. Sabdariffa leaf extract synthesized silver nanoparticles

Fig. 4.42 Low angle powder XRD pattern of Ag-SBA-15

Fig. 4.43 Wide angle powder XRD pattern of Ag-SBA-15

Fig. 4.44 TEM images of Ag-SBA-15 (a) hexagonal pore symmetry (b) ordered mesopore channels (c) SAED pattern (d) AgNP in the silica matrix

Fig. 4.45 N2 adsorption-desorption isotherm of Ag-SBA-15 at -196 °C

Fig. 4.46 BJH pore size distribution of Ag-SBA-15 from adsorption branch; inset-desorption branch

Fig. 4.47 BET plot of Ag-SBA-15

Fig. 4.48 Representative t-plot of Ag-SBA-15 in 3.5-5Å

Fig. 4.49 UV-Vis spectra showing 4-nitrophenol reduction by Ag-SBA-15

Fig. 4.50 Linear fit pseudo-first order kinetics plot of 4-NP reduction in presence of Ag-SBA-15

Fig. 4.51 UV-Visible spectra showing ET reduction of hexacyanoferrate (III)

Fig. 4.52 Linear fit pseudo-first of kinetics plot of ET reaction between ferricyanide and thiosulfate ion in presence of Ag-SBA-15

Fig. 5.1 Low angle powder X-Ray diffraction pattern of NH₃-SBA-15

Fig. 5.2 N₂ adsorption-desorption isotherm of NH₃-SBA-15

Fig. 5.3 BET plot of NH₃-SBA-15 materials from isotherm data

Fig. 5.4 Representative t-plot within the thickness range 3.5-5Å

Fig. 5.5 Pore size distribution of the adsorption branch; inset-desorption branch
Fig. 5.6 Transmission Electron Micrographs of NH₂-SBA-15 showing ordered hexagonal pore symmetry 134

Fig. 5.7 FT-IR spectrum of SBA-15 135

Fig. 5.8 FT-IR spectrum of NH₂-SBA-15 136

Fig. 5.9 TGA plot of NH₂-SBA-15 136

Fig. 5.10 Mass spectrum of the Knoevenegel condensation product 138

Fig. 5.11 Mass spectrum of methyl cinnamate 139

Fig. 5.12 ¹H-NMR of methyl cinnamate 139

Fig. 5.13 ¹³C-NMR spectrum of methyl cinnamate 140

Fig. 5.14 Methylene Blue 140

Fig. 5.15 Calibration plot of Methylene Blue 141

Fig. 5.16 Absorbance vs time plot for methylene blue removal 142