RSC Advances Supplementary Information

Sinter-resistant gold nanoparticles encapsulated by zeolite nano-shell for oxidation of cyclohexane

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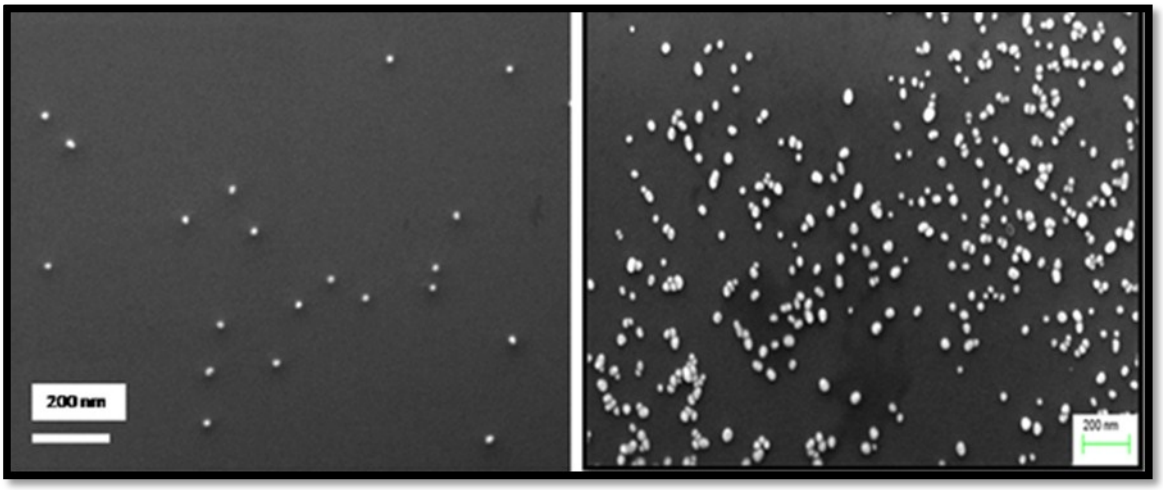

Figure S1.Scanning electron micrograph of bare gold nanoparticles

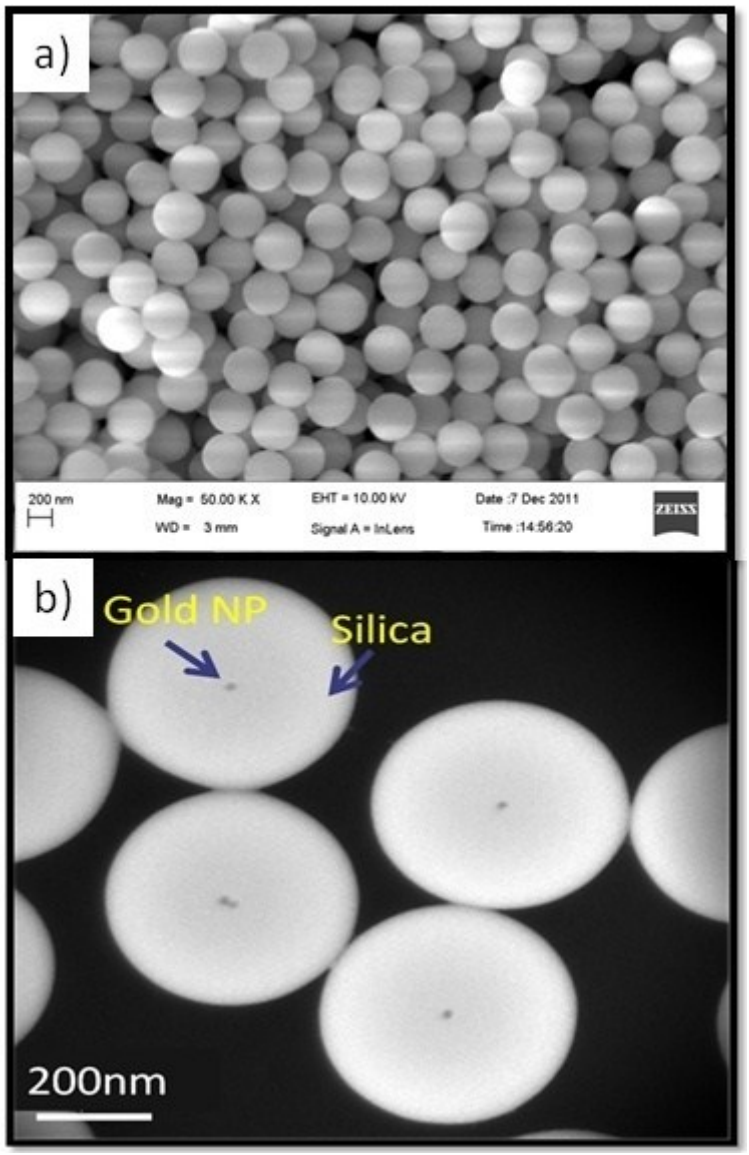

***Figure S2*. a)** Scanning electron micrograph of silica-coated gold nanoparticles **b)** Transmission electron micrograph of silica-coated gold nanoparticles

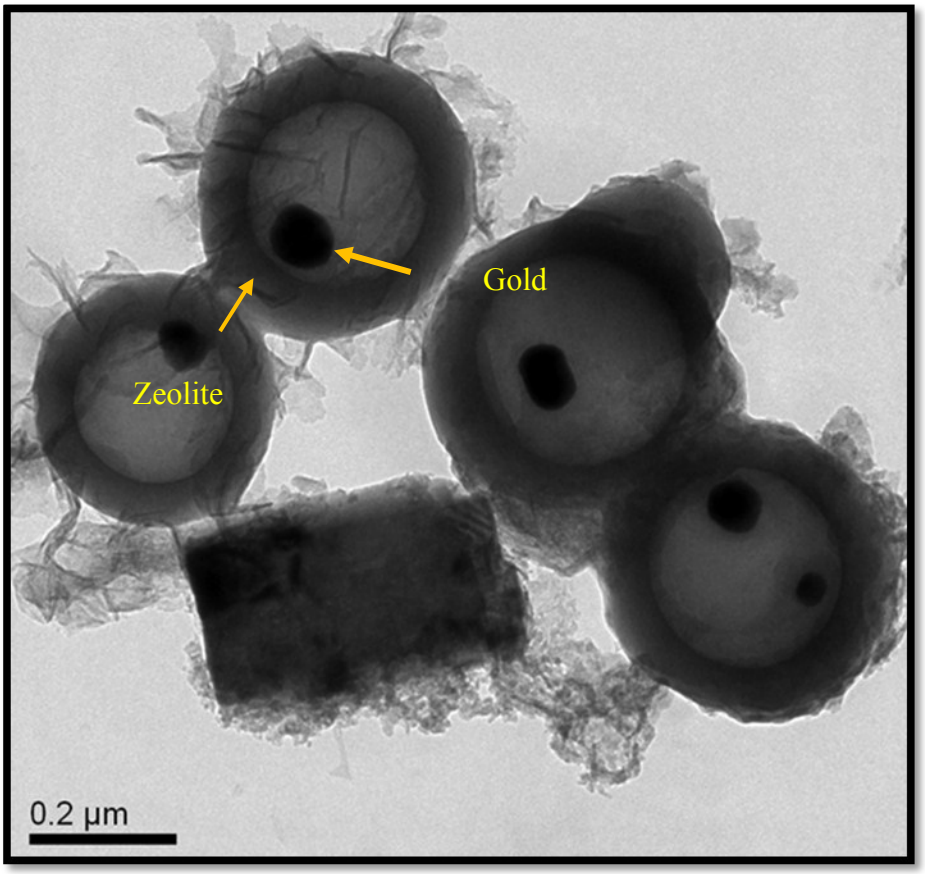

Figure S3. Transmission electron micrograph of Au@ZSM-5

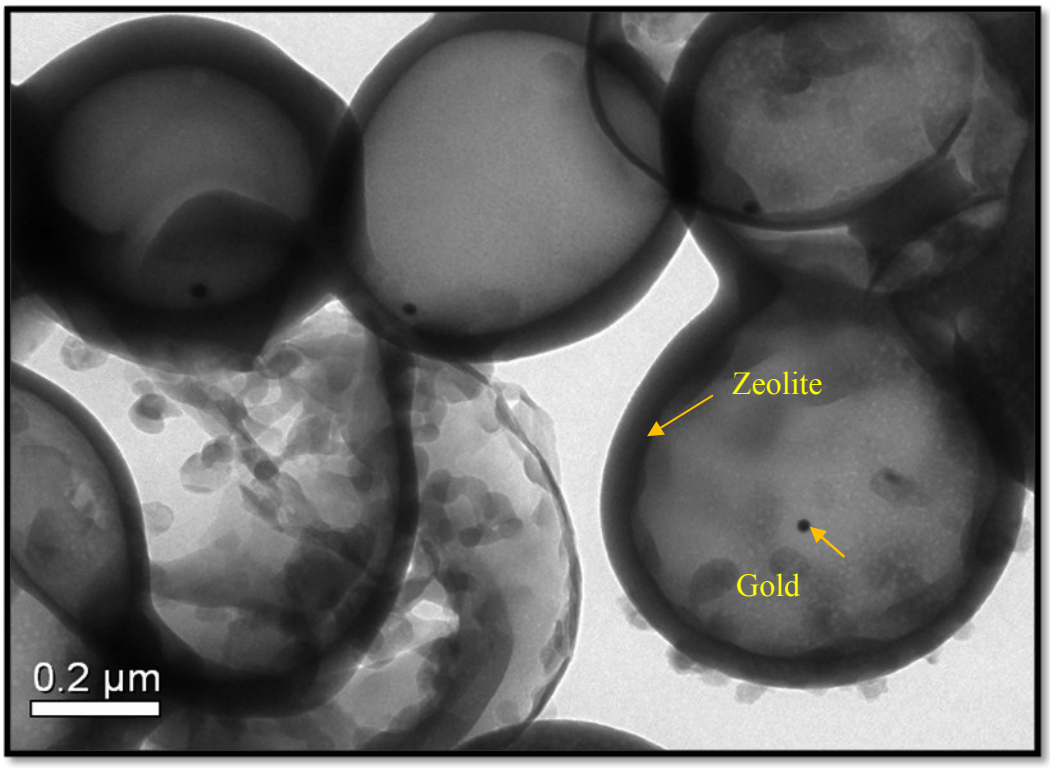

Figure S4. Transmission electron micrograph of Au@MCM-22

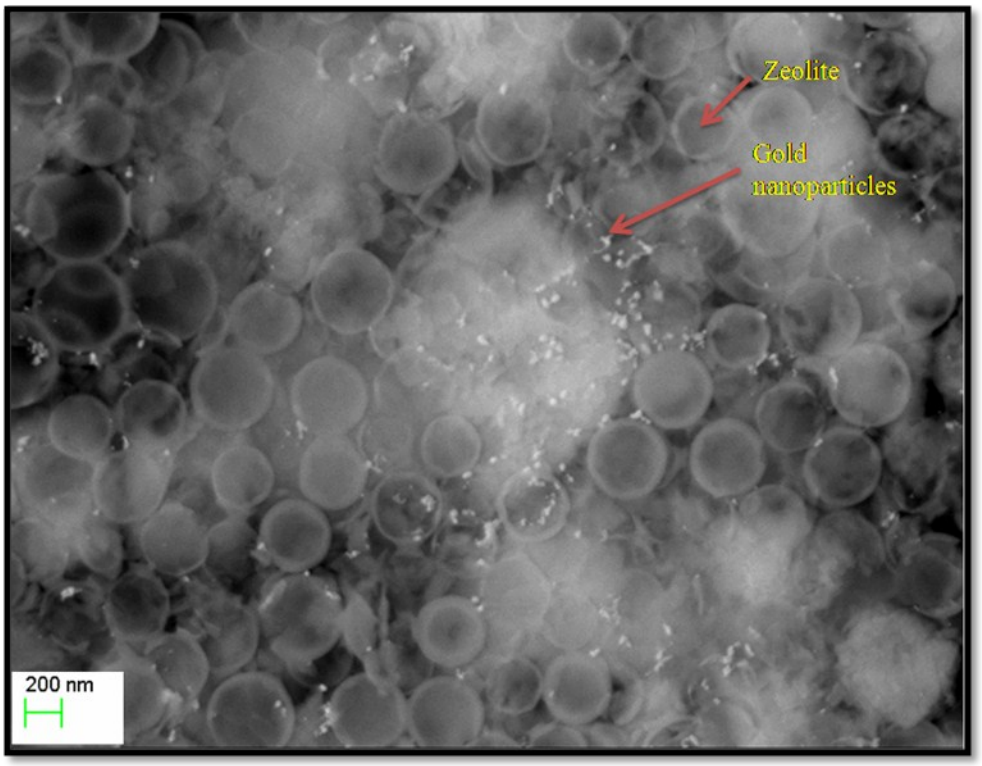

Figure S5. Scanning electron micrograph of gold supported on the surface of ZSM-5

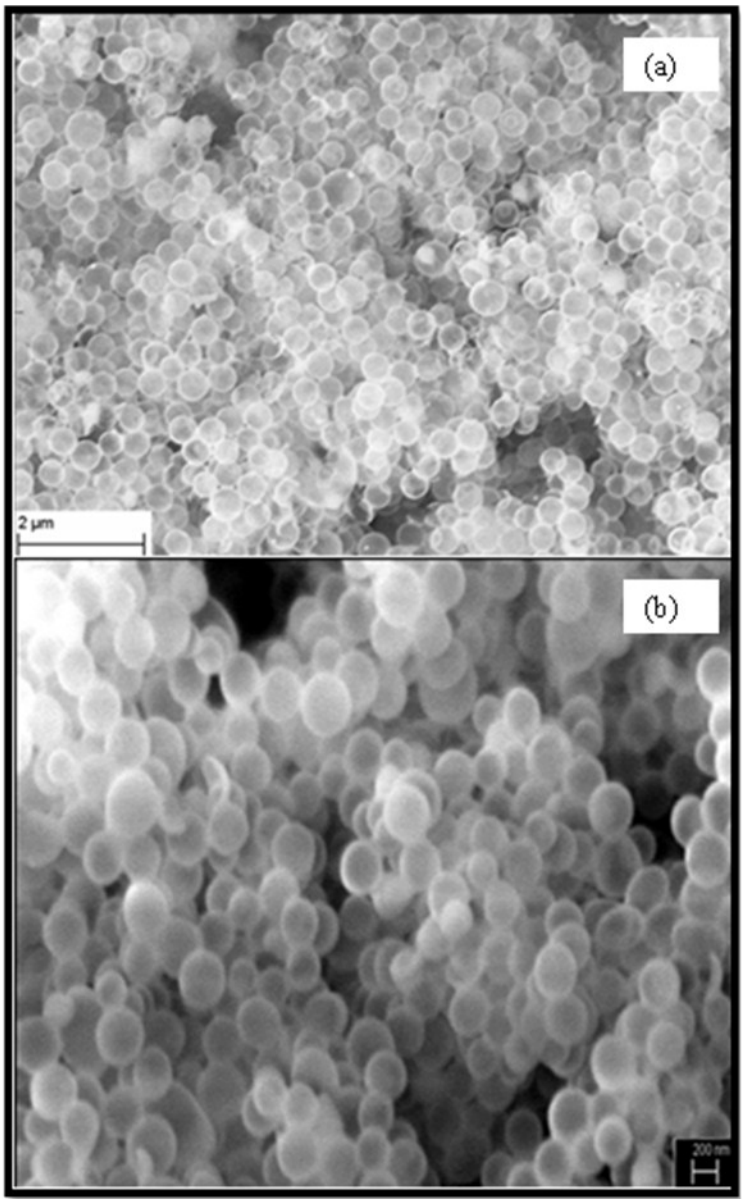

Figure S6.(a) Scanning electron micrograph of bare ZSM-5 (b) Scanning electron micrograph of bare MCM 22

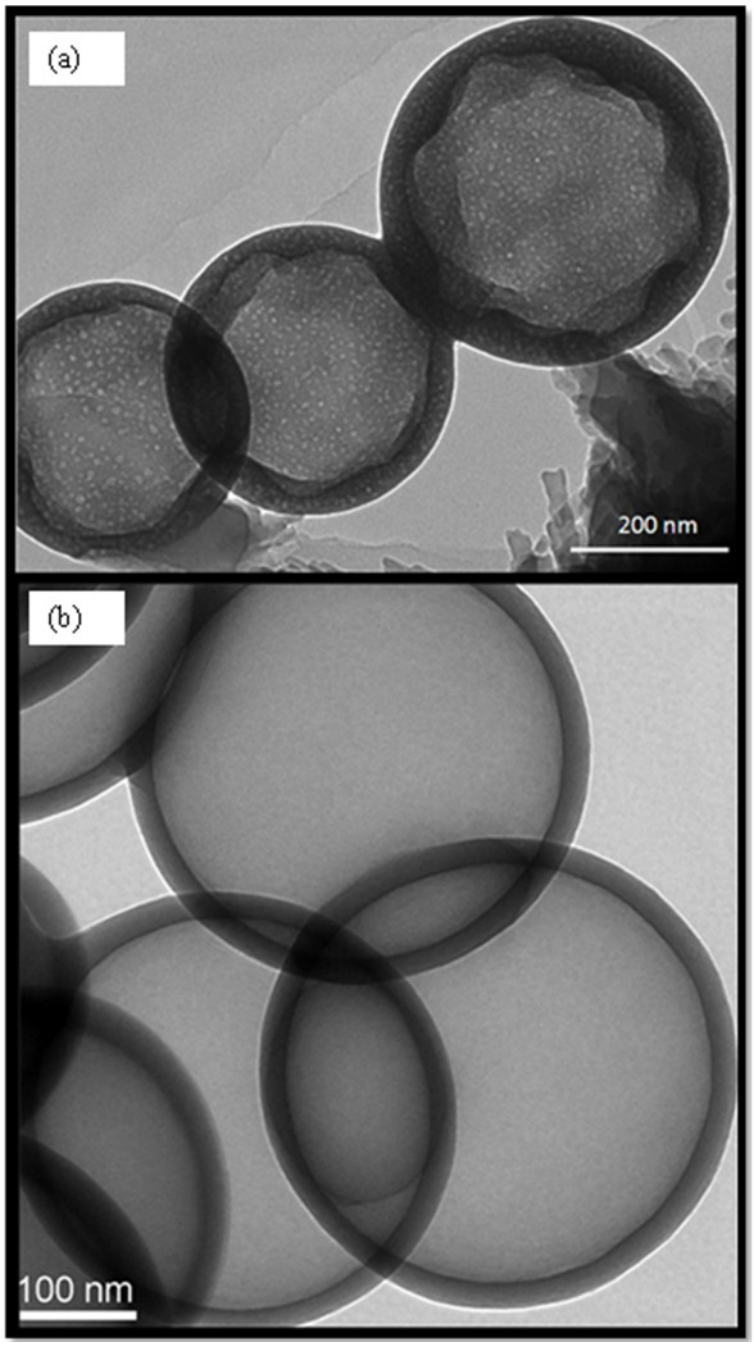

Figure S7.(a) Transmission electron micrograph of bare ZSM-5 (b) Scanning electron micrograph of bare MCM 22

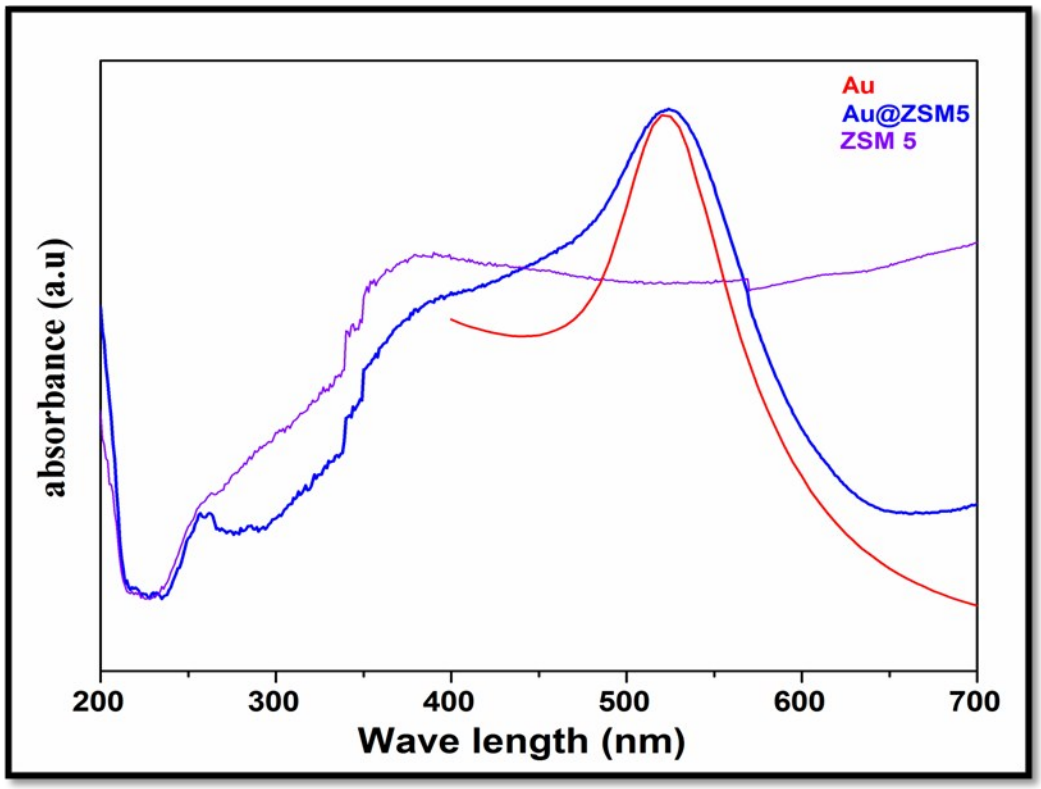

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Figure S8. UV-Vis spectra for Au@ZSM-5

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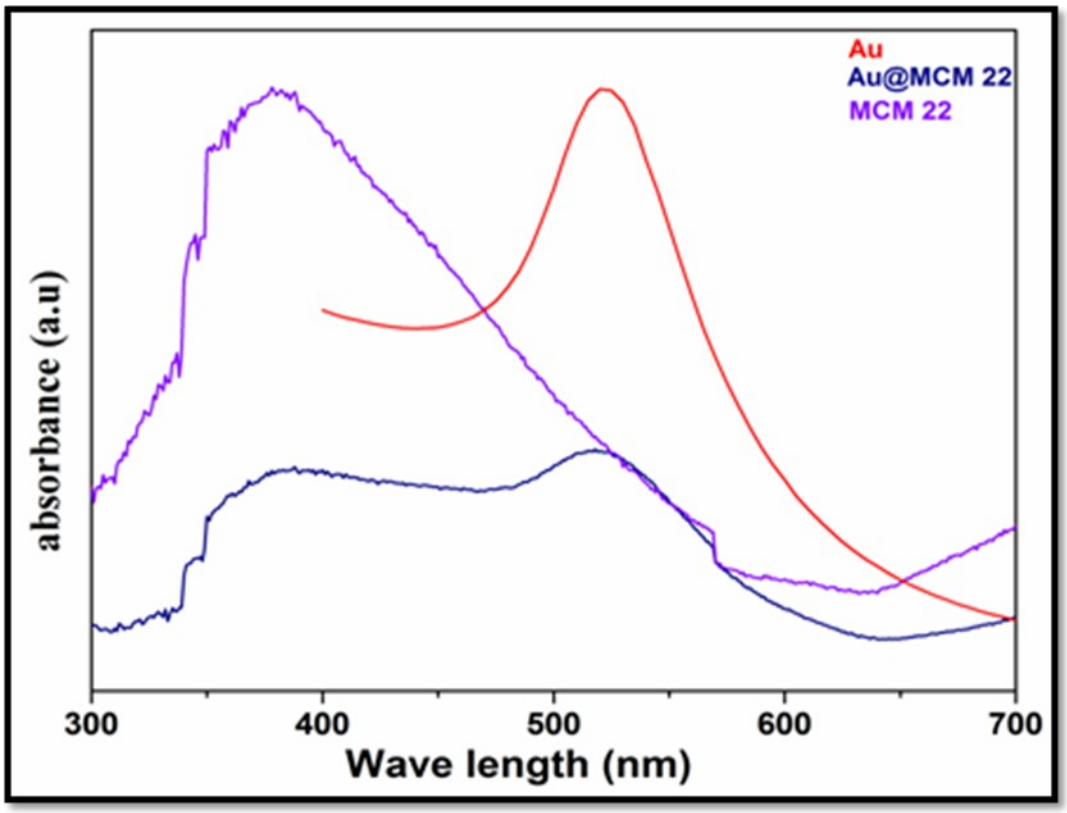

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Figure S9. UV-vis spectra for Au@MCM-22

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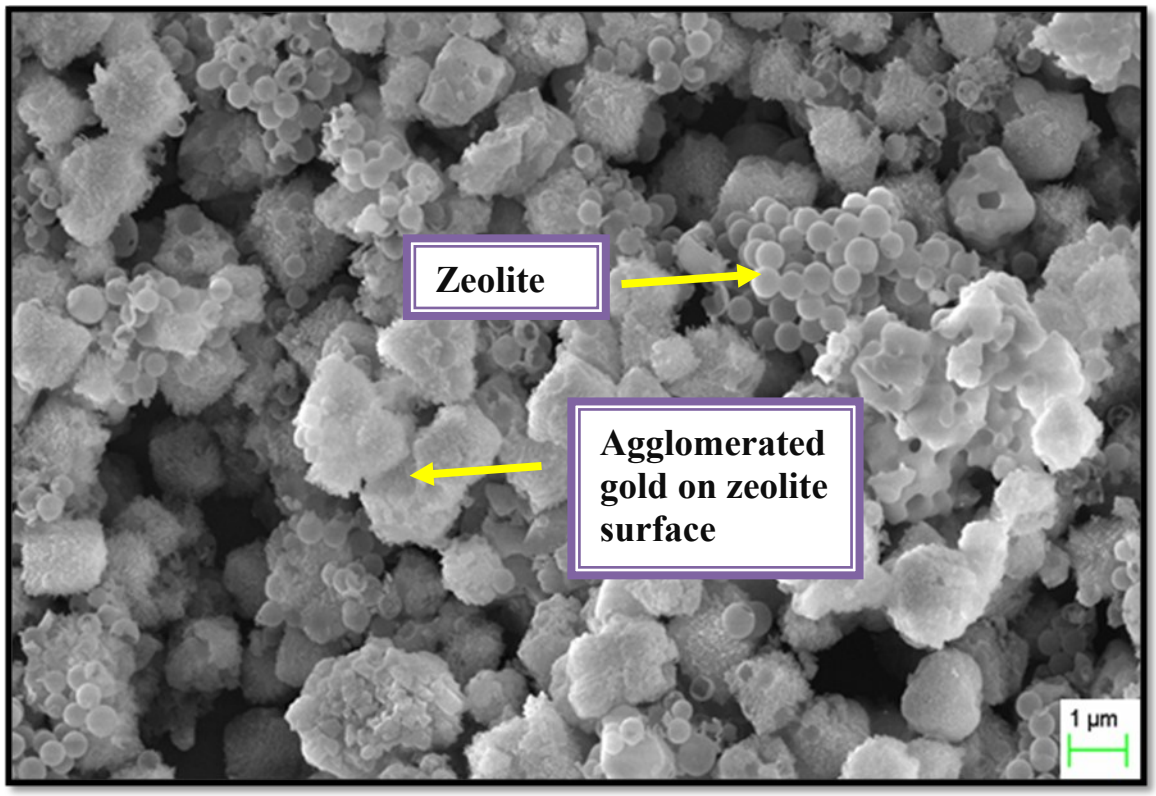
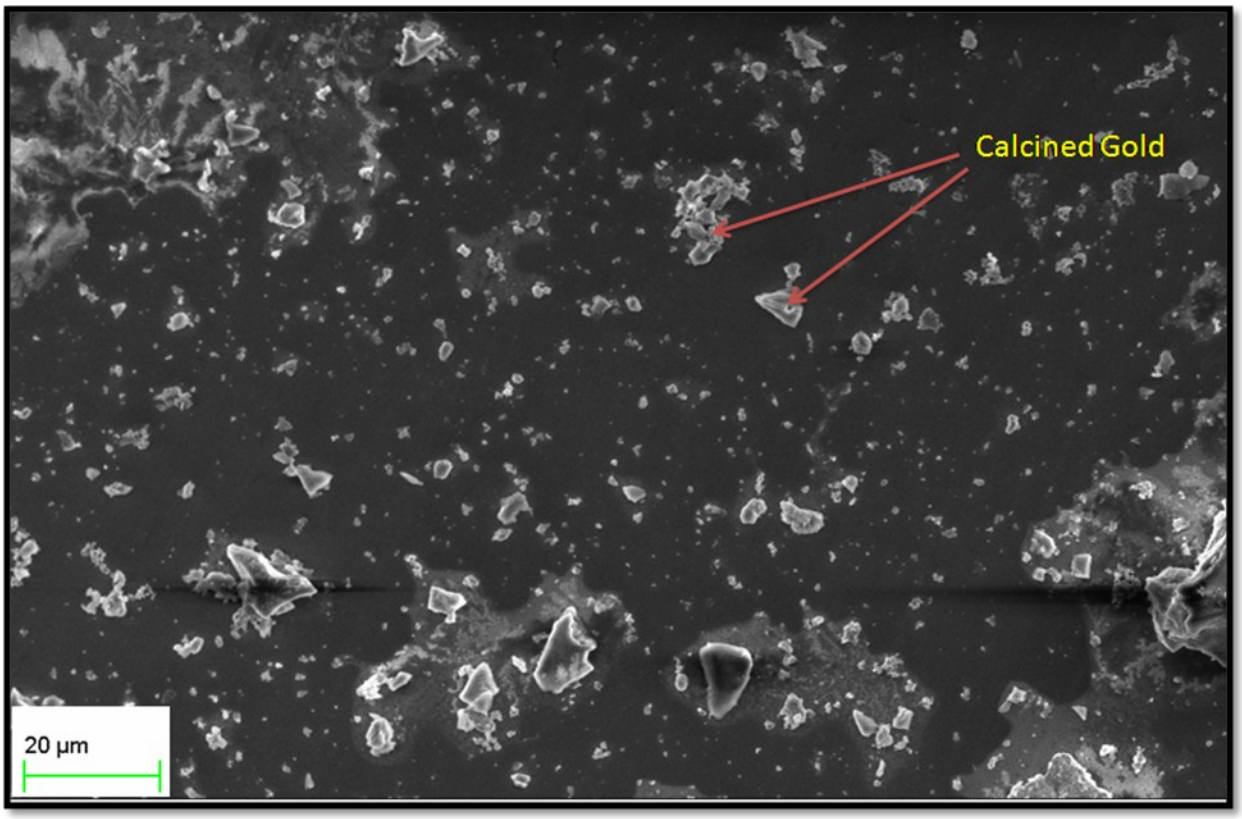


Figure S10. Scanning electron micrograph of calcined sample of gold supported on the surface of ZSM-5 at 500^0C



144 ***Figure S11.*** Scanning electron micrograph gold nanoparticles calcined at 500°C

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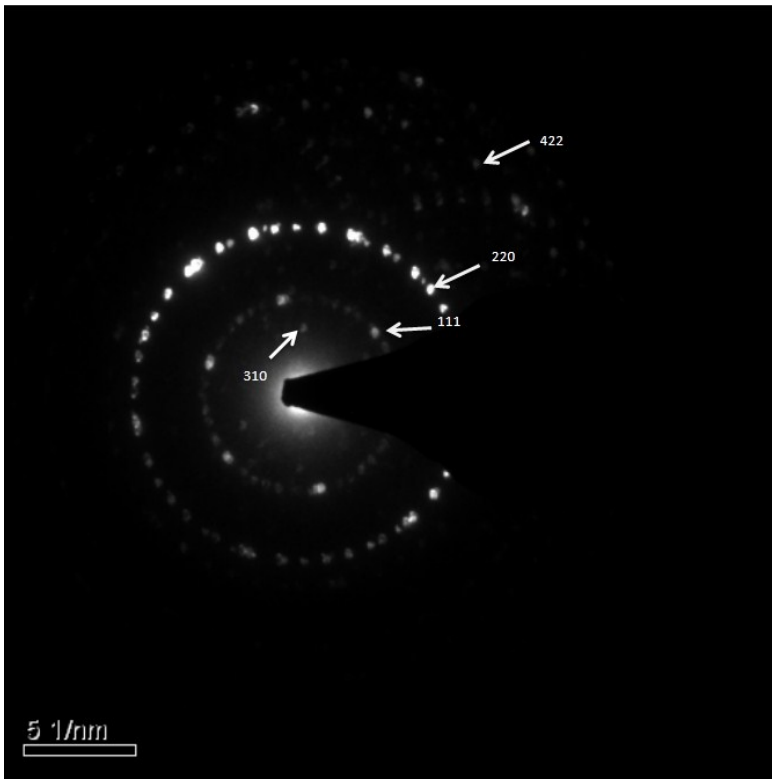

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Figure S12. a. Selected area electron diffraction (SAED) analysis for Au@MCM-22

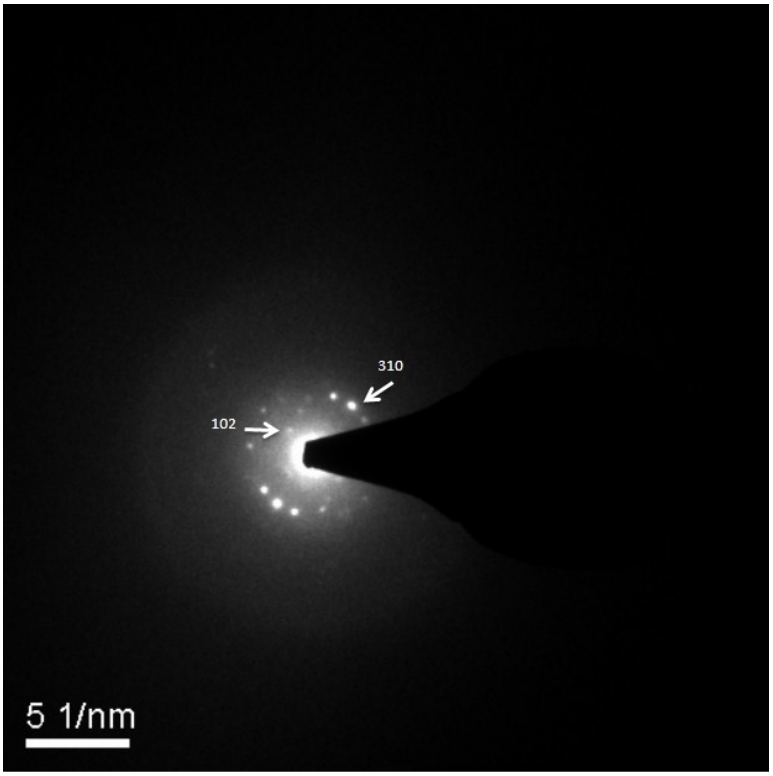

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Figure S12. b. Selected area electron diffraction (SAED) analysis for bare MCM-22

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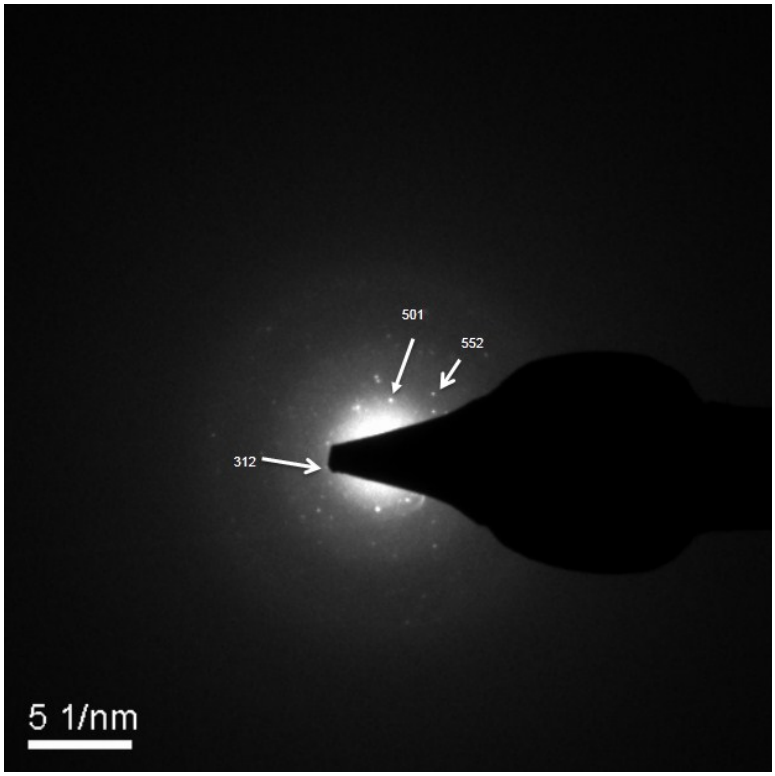

Figure S12. c. Selected area electron diffraction (SAED) analysis for ZSM-5

The indexing of the freshly prepared samples was carried out and the corresponding diffraction planes are mentioned in Figure S12, which confirms the zeolites shell as MCM-22 and ZSM-5 of prepared samples Au@MCM-22 and Au@ZSM-5. Figure S12 (a) corresponds to the SAED pattern of Au@MCM-22 which was reported in the previously submitted manuscript. Figure S12 (a) shows the gold diffraction pattern [JCPDS 04-0784] from (111), (220) and (422) planes. The diffraction from (310) plane corresponds to MCM-22 [JCPDS 04-0784]. Figure S12(b) corresponds to SAED patterning for bare MCM-22 zeolite which gives the diffraction from (102) and (310) planes. Figure S12(c) corresponds to the diffraction from bare ZSM-5, which shows the diffraction pattern from (312), (501) and (552) planes.

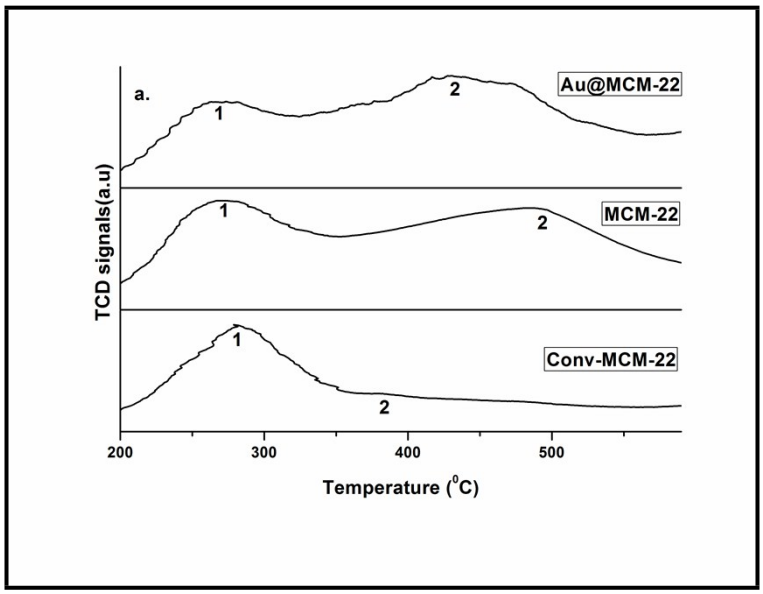

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Figure S13.a. NH_3 TPD profiles for MCM-22 catalyst

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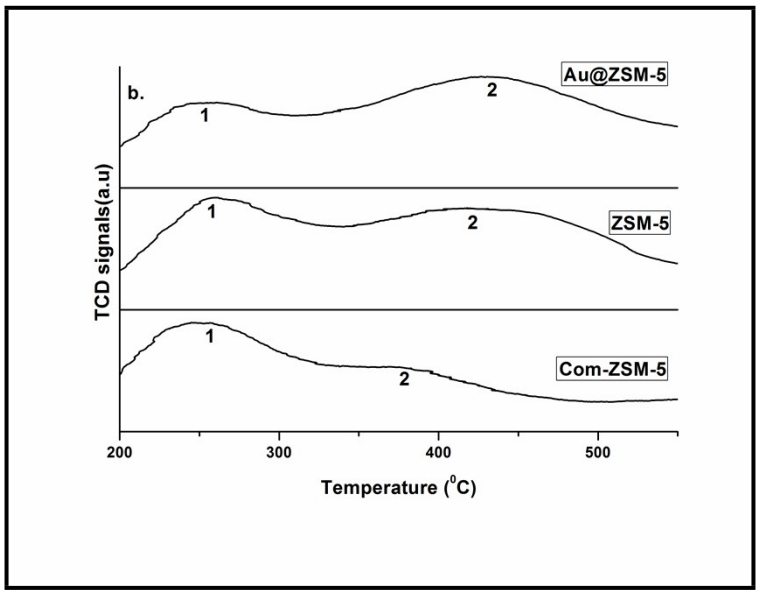

186 ***Figure S13.b.*** NH_3 TPD profiles for ZSM-5 catalyst

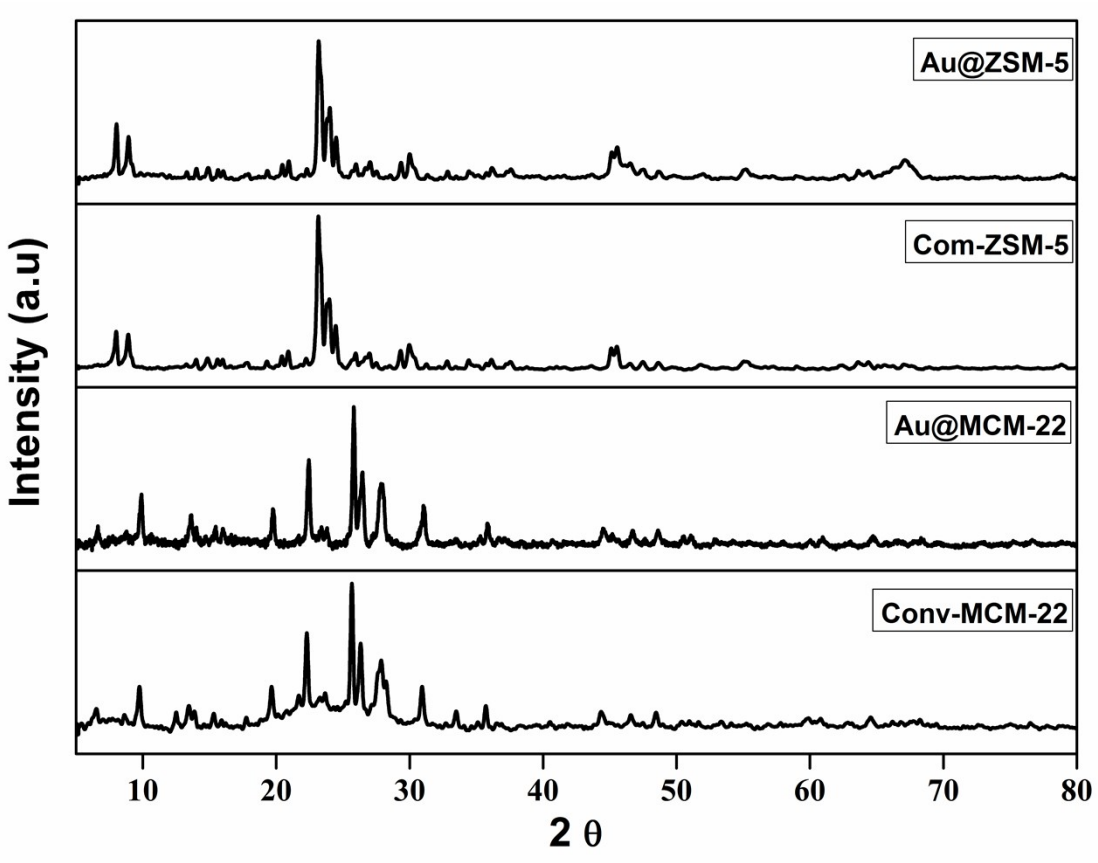

Figure S14. XRD analysis of Com-ZSM-5 and Conv-MCM-22

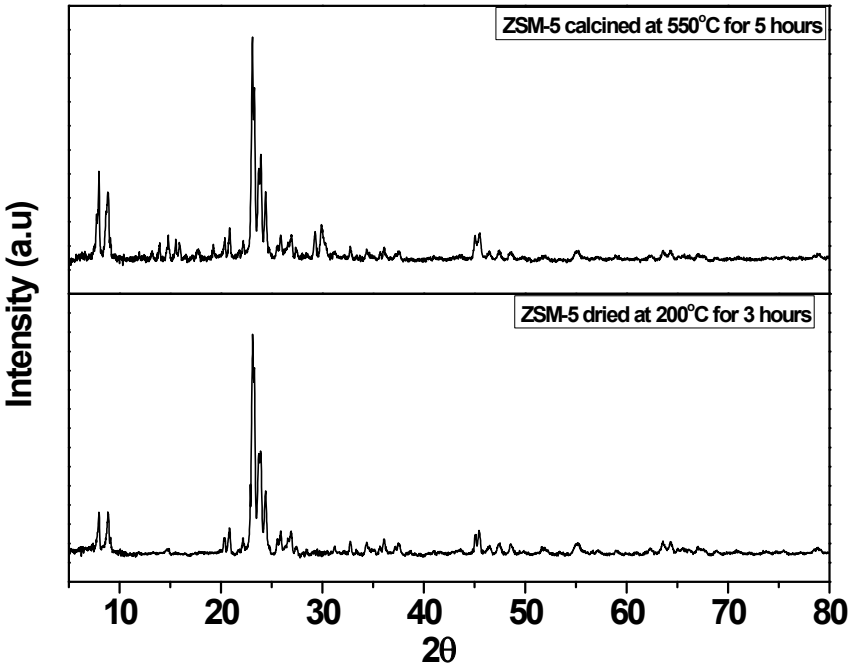

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Figure S15. XRD analysis of Au@ZSM-5 calcined at 550^{0}C for 5hours and dried at 200 ^{o}C for 3hours

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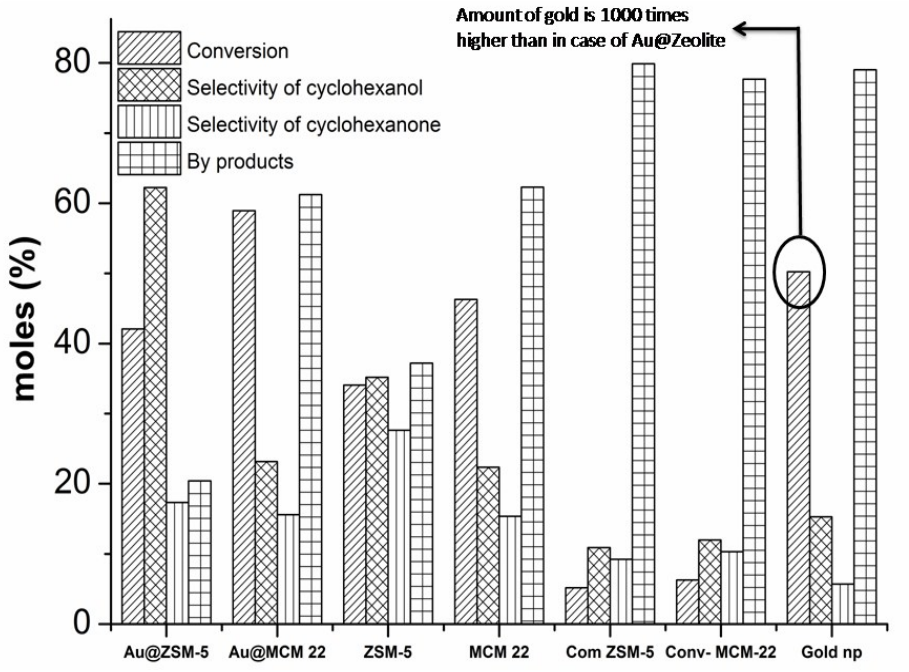
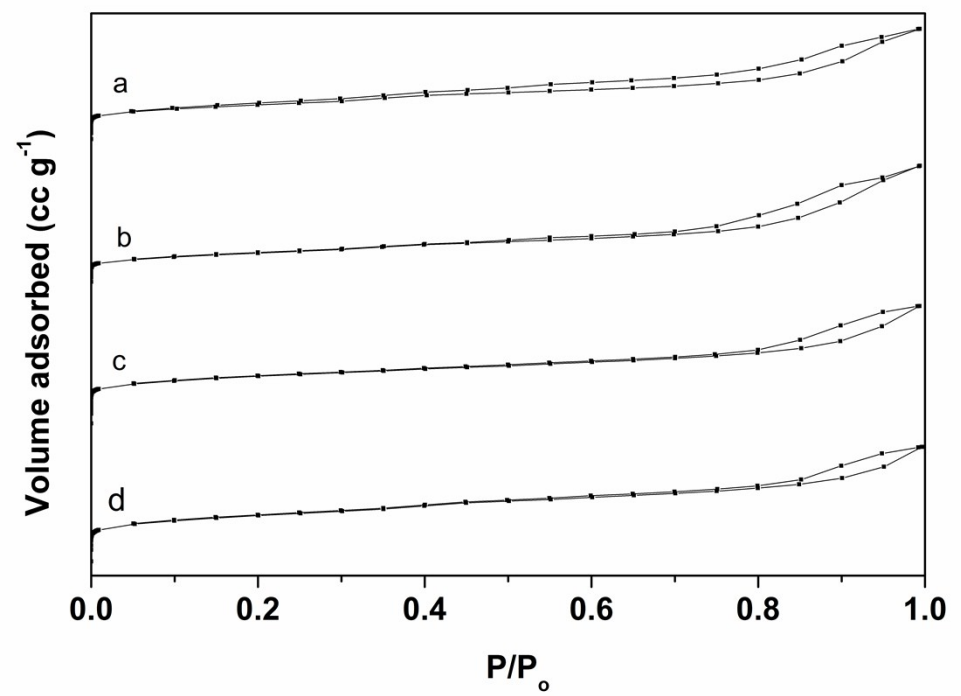


Figure S16.Conversion of cyclohexane and selectivity for products for different catalyst. Amount of gold in case of control experiment was higher (1000 times) than in case of Au@ZMS-5 and Au@MCM-22.



226 ***Figure S17.*** N_2 adsorption−desorption isotherms of (a) ZSM-5, (b) Au@ZSM-5, (c) MCM-22, and (d) Au@MCM-22

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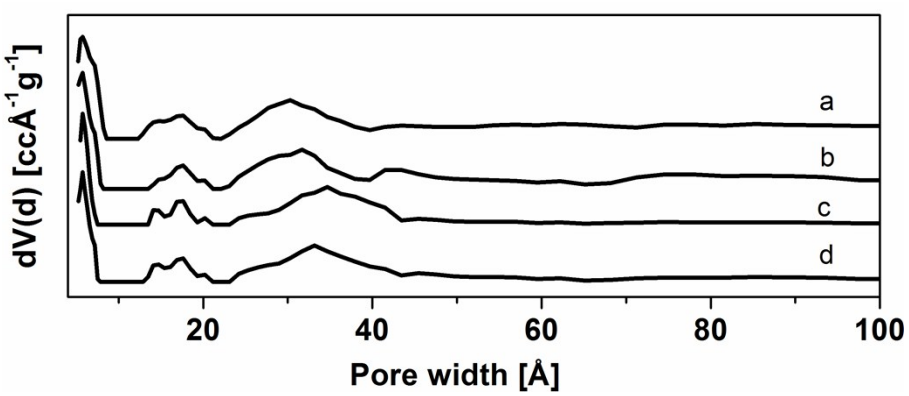

Figure S18. Pore diameter distribution curves a) Au @ ZSM-5, b) ZSM-5, c) Au @ MCM-22 and d) MCM-22

Table S1: Textural Property of prepared zeolite samples

Sample	S_{BET} (m^2/g)	V_{micro} (cm^3/g)	V_{meso}[a] (cm^3/g)	V_{total} (cm^3/g)
ZSM-5	421	0.19	0.46	0.65
MCM-22	398	0.18	0.35	0.53
Au@ZSM-5	409	0.18	0.42	0.60
Au@MCM-22	392	0.17	0.34	0.51

[a] $V_{meso} = V_{total} - V_{micro}$

Table S2: Elemental compositions determined by X-ray fluorescence (XRF)

Sample	**Si%**	**Al%**	**Na%**	**O%**	**Au%**
Au@MCM-22	30.98	6.08	6.03	56.9	0.01
Au@ZSM-5	54.34	8.79	8.5	28.36	0.01
MCM-22	32.03	6.83	6.29	54.85	-
ZSM-5	56.07	6.52	6.13	31.28	-

Table S3: Turn over number[a] and Turn over frequency[b]

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Sample	**TON[a]**	**TOF[b] (h^{-1})**
Au@MCM-22	1788	596
Bare MCM-22	1492	497
Au@ZSM-5	1528	509
Bare ZSM-5	1485	495
Conv-MCM-22	720	240
Com-ZSM-5	409	136

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