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Supplementary Information

Synthesis and Characterization of Co_3O_4 Immobilized on Dipeptide-Functionalized Silica-Coated Magnetite Nanoparticles: As a Catalyst for Selective Aerobic Oxidation of Alcohols

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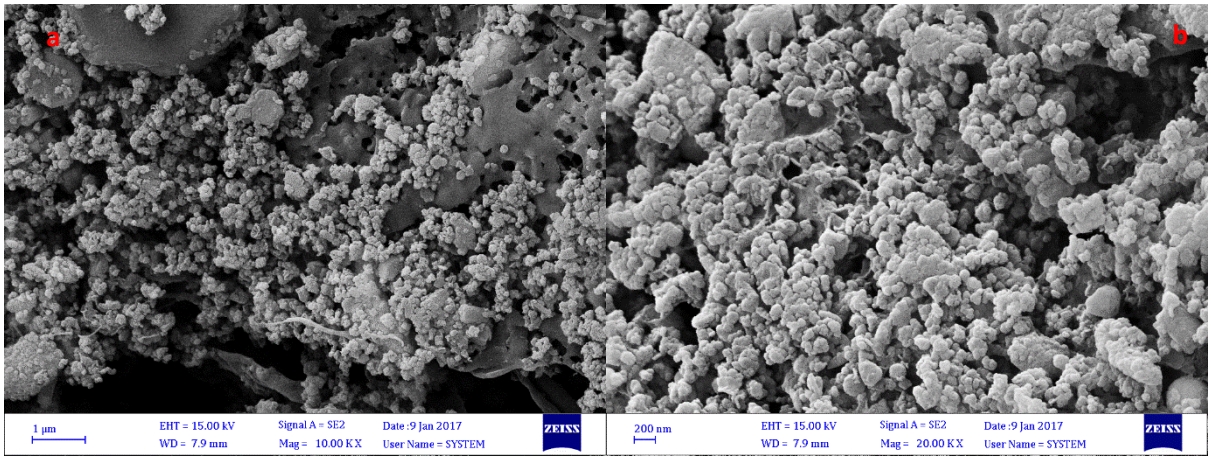
1. FE-SEM and TEM measurements of the Co_3O_4@SCM-UIL catalyst

FE-SEM, Mapping and EDX analyses were performed on a ZEISS SIGMA VP-500 instrument. TEM analysis was performed using a ZEISS-EM 10C at an acceleration voltage of 100 kV. The sample was sputtered by gold to avoid undesirable electron charging. As shown in Fig. 1Sa and 1Sb, the SCM-Cl particles show semi-spherical morphology with degrees of aggregation between particles. The average diameters of these particles are 35-57 nm. In the case of Co_3O_4@SCM-UIL (Fig. 1Sc, 1Sd and 1Sf), the diameters of the nanoparticles have not changed in comparison with the SCM-Cl particles but low degrees of aggregation are observed. By EDXS analysis, cobalt along with oxygen was detected in Co_3O_4@SCM-UIL particles (Fig. 1Se), suggesting that they consist of Co_3O_4. In the mapping technique of the catalyst, in addition to presence of the desired elements, uniform dispersion of the Co_3O_4 NPs onto the functionalized magnetic NP_S is also observed (Fig. 1Sg). In the TEM images of SCM-Cl in Fig. 1Sh, 1Si and 1Sj, the core-shell structure with Fe_3O_4 cores in size range of 8 to 10 nm is observed. It is seen the same structure for the SCM-UIL NPs in Fig. 1Sn before immobilization of Co_3O_4 NPs but after immobilization of Co_3O_4 NPs (Fig. 1Sk, 1Sl, 1Sm and 1So), two types of small particles are visible. Particles with average sizes of 8-10 nm (darker black spots) are attributed to the Fe_3O_4 NPs and particles lower than 5 nm (brighter black spots) related to Co_3O_4 NPs. These small particles (lower than 5 nm) agree very well with the XRD pattern showing only very weak signals of Co_3O_4 (Fig. 2c).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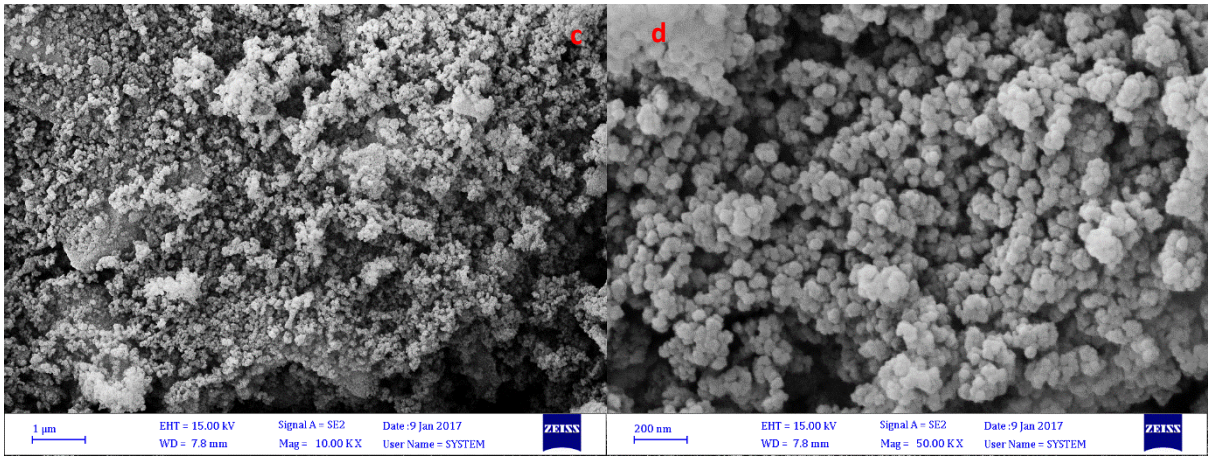
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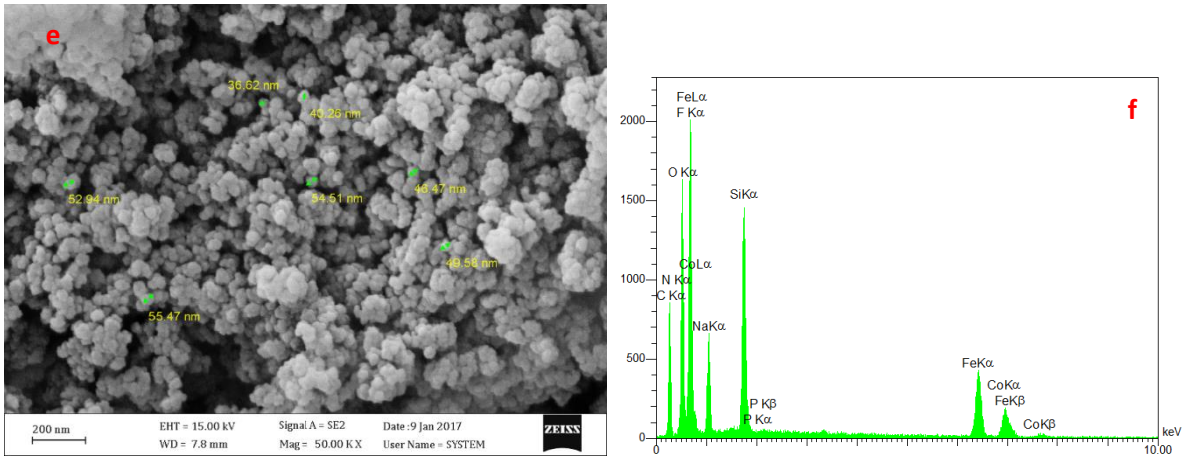
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52.94 nm
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46.47 nm
48.58 nm
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f
FeLα
F Kα
O Kα
SiKα
CoLα
N Kα
C Kα
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0
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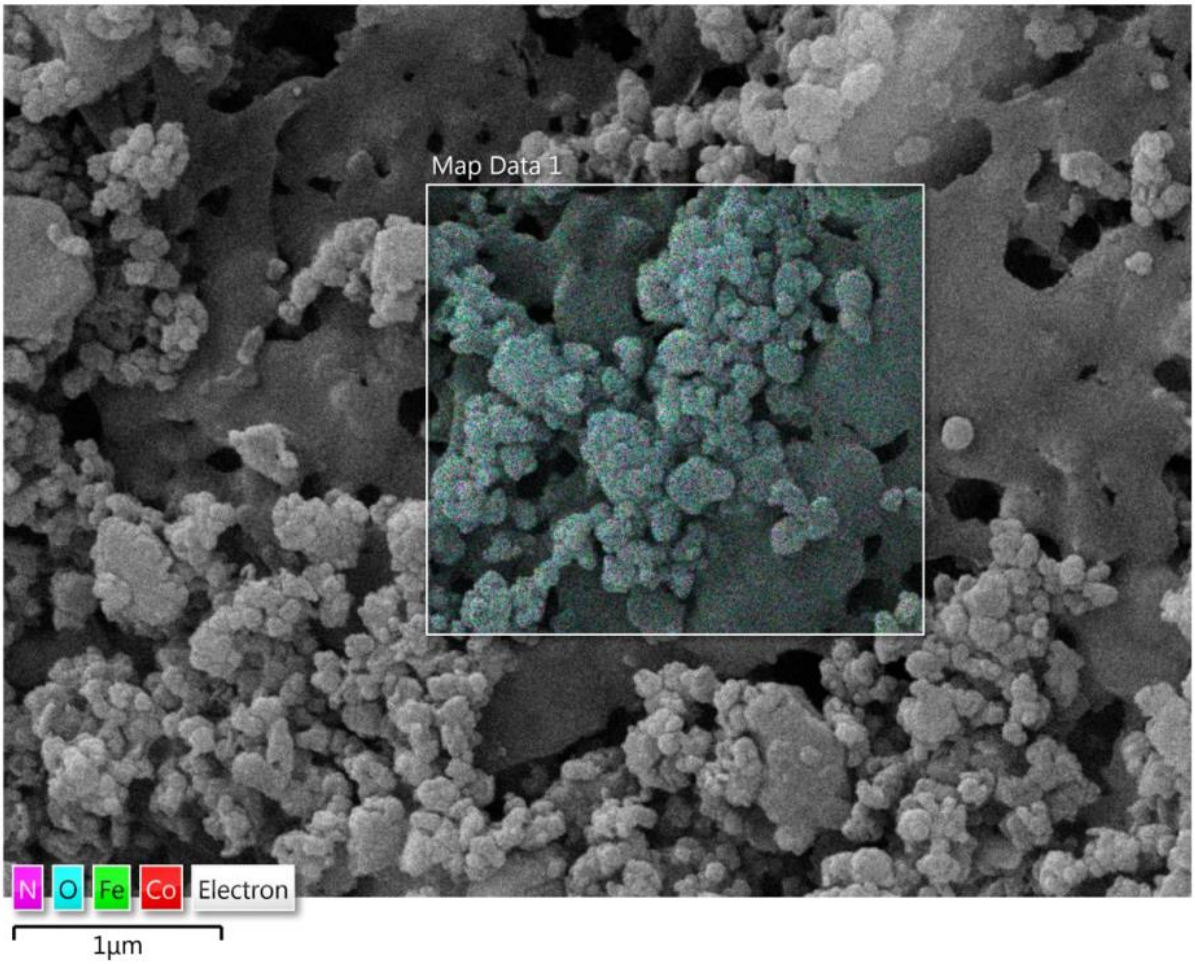
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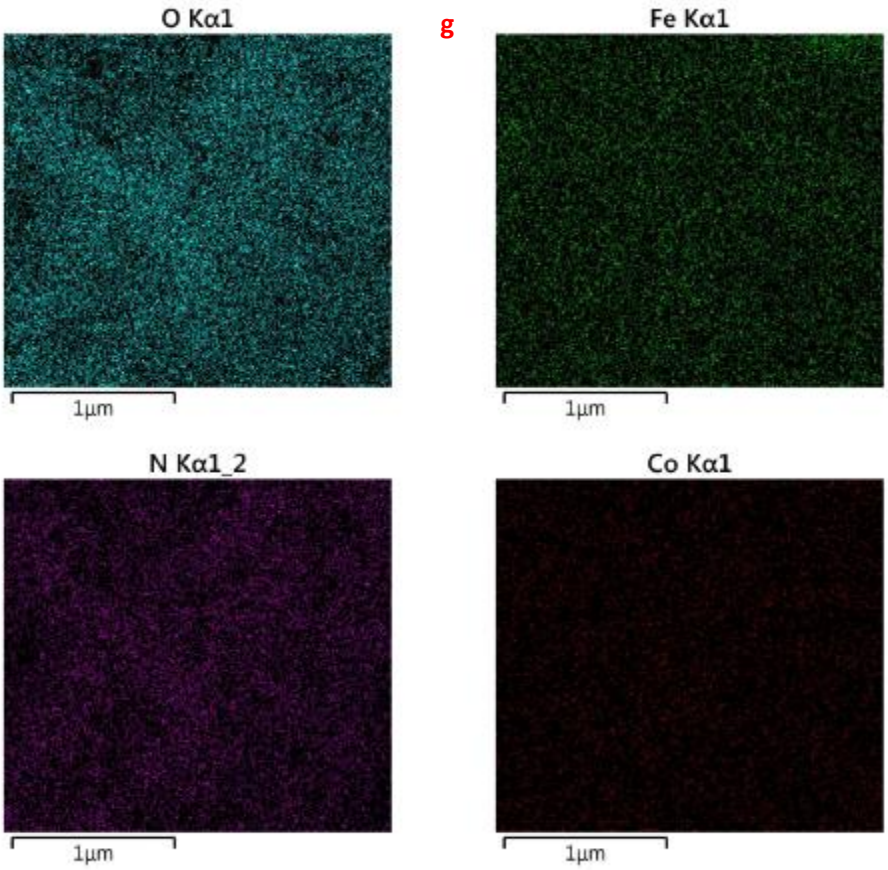
Fe
Co
Electron
1µm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Fe Kα1
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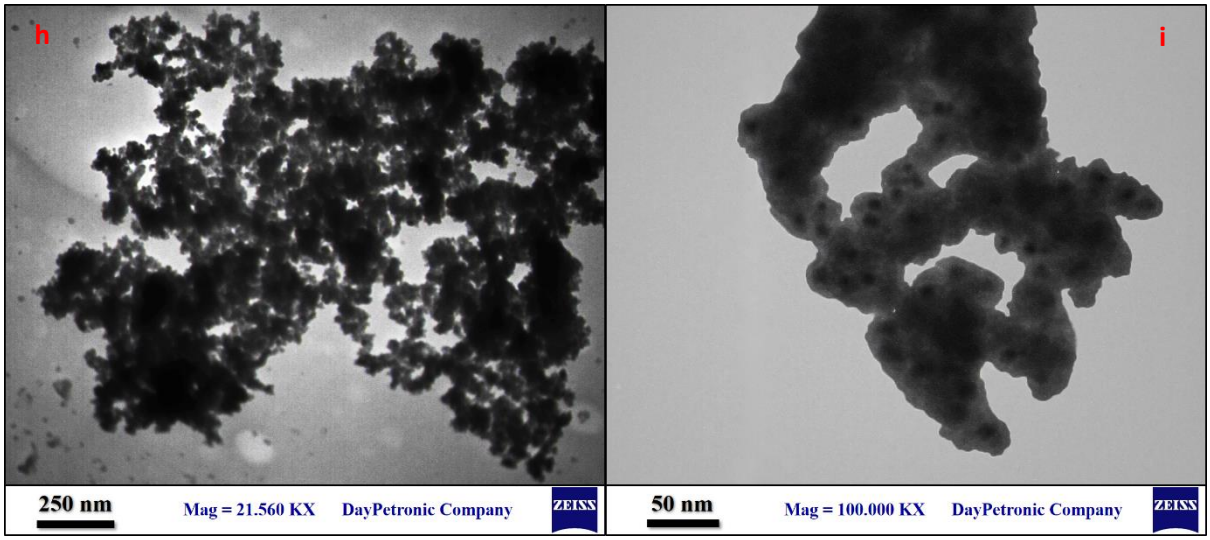
1μm
N Kα1_2
Co Kα1
1μm
1μm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DayPetronic Company
ZEISS
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DayPetronic Company
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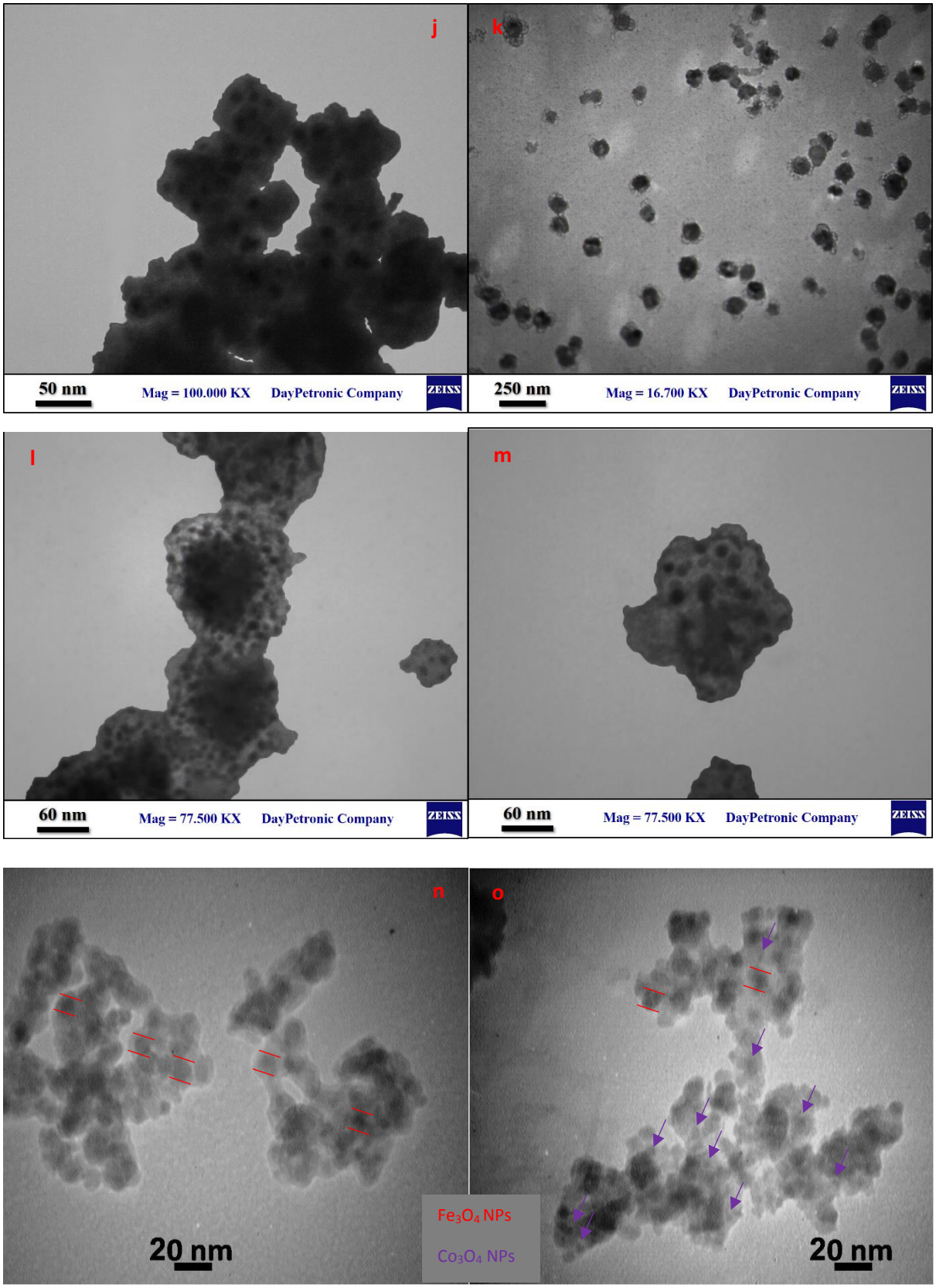
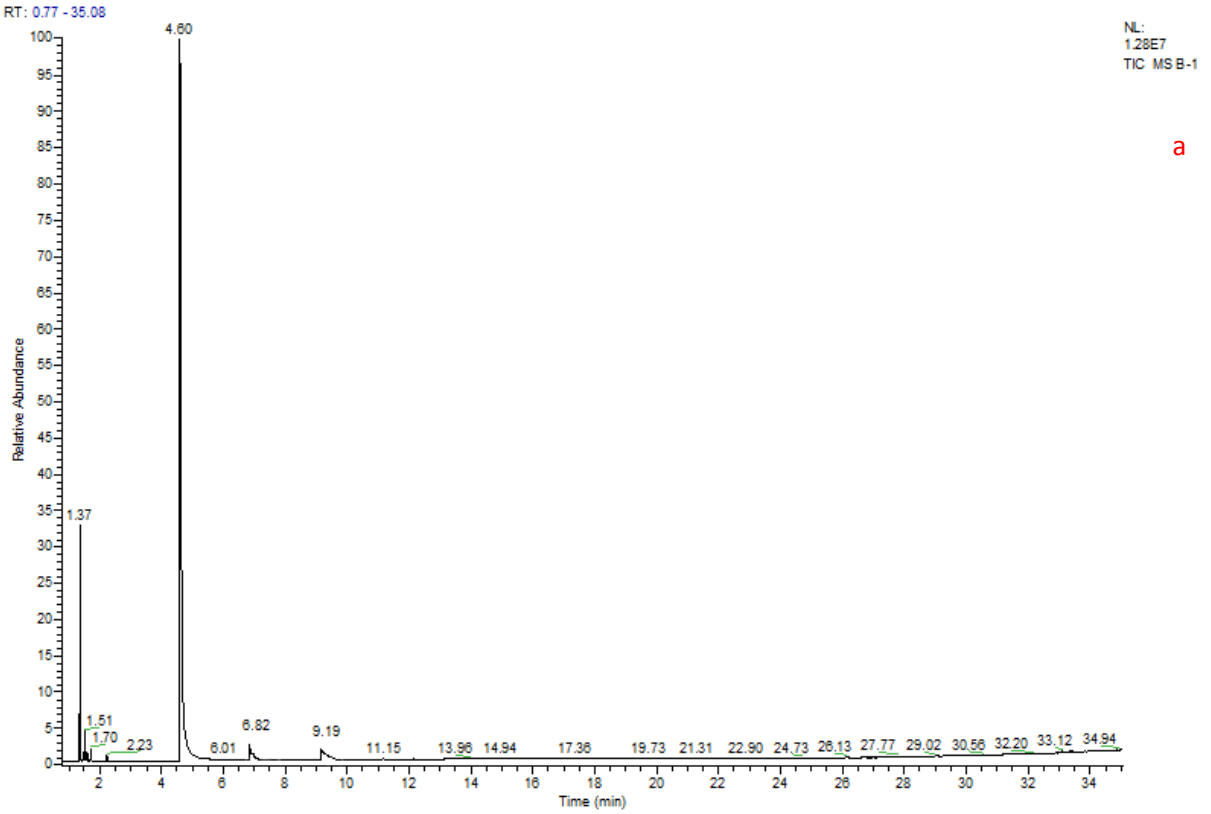


Figure 1S. The FE-SEM images of SCM-Cl (a and b) and Co_3O_4@SCM-UIL (c, d and e), EDX analysis of Co_3O_4@SCM-UIL (f), mapping analysis of Co_3O_4@SCM-UIL (g), and TEM images of SCM-Cl (h, i and j), Co_3O_4@SCM-UIL (k, l, m and o) and SCM-UIL (n).

2. GC-mass analysis for oxidation of benzyl alcohol to benzaldehyde at optimum conditions

The products were analyzed by a Varian 3900 GC. Based on obtained results from GC-mass analysis for oxidation reaction of benzyl alcohol in acetonitrile as solvent under O_2 blowing at 70 ^{o} C in the presence of Co_3O_4@SCM-UIL as catalyst and undecane was used as an internal standard. The main product was benzaldehyde (76%) and 14% of benzoic acid as a by-product produced, while 10% of benzyl alcohol was not reacted. The results are shown in Fig. 2S.



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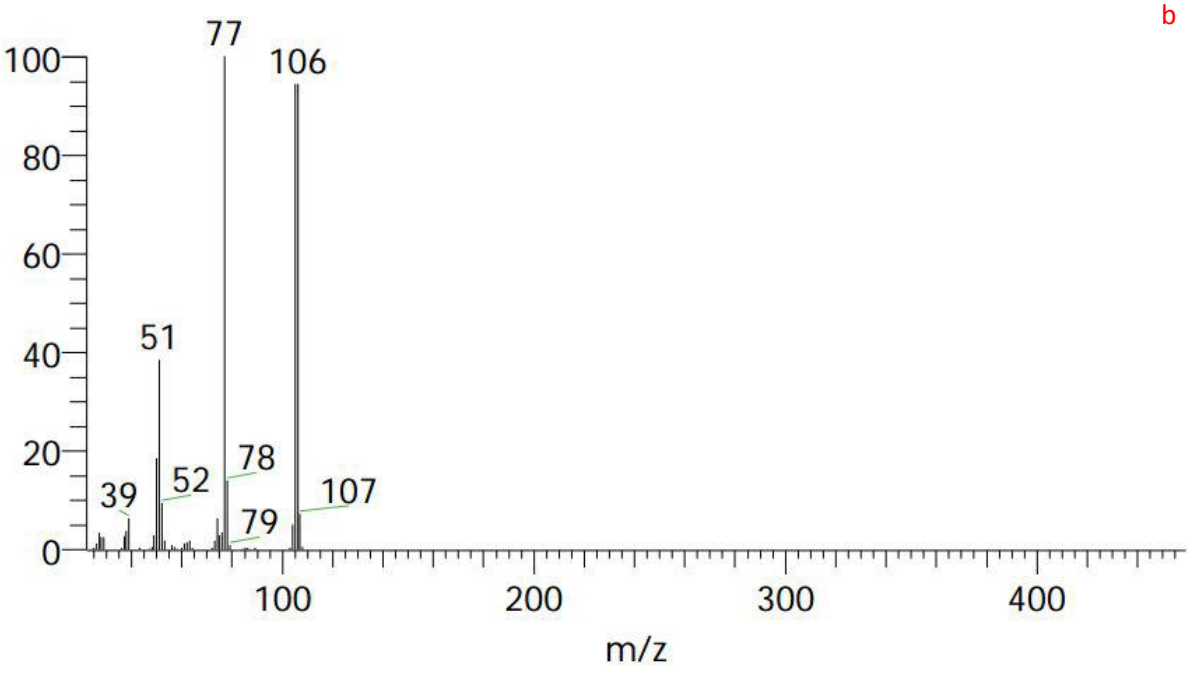
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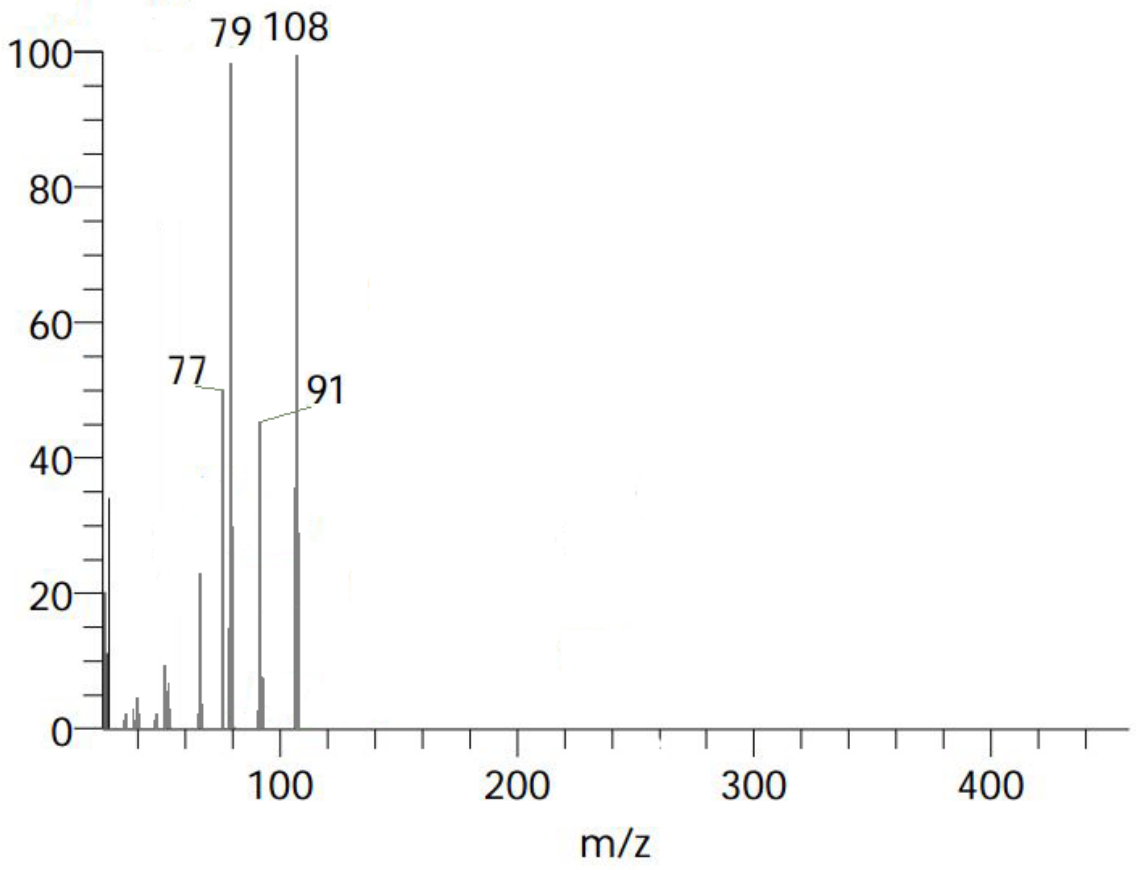
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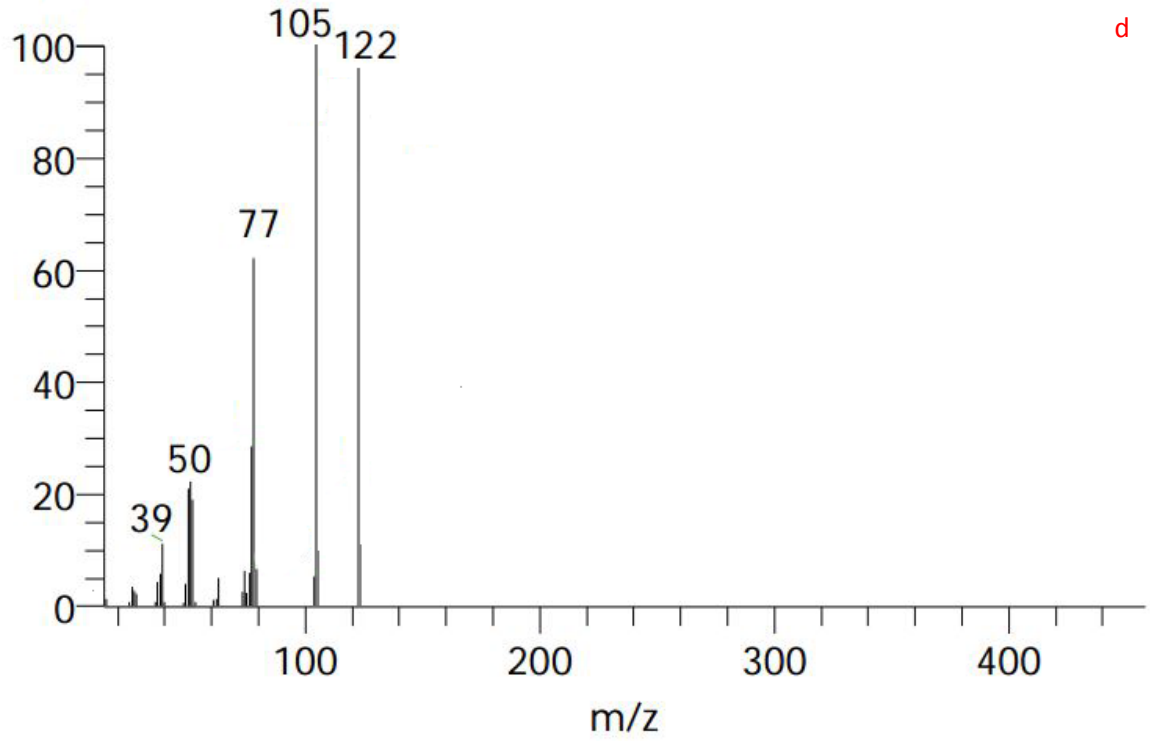
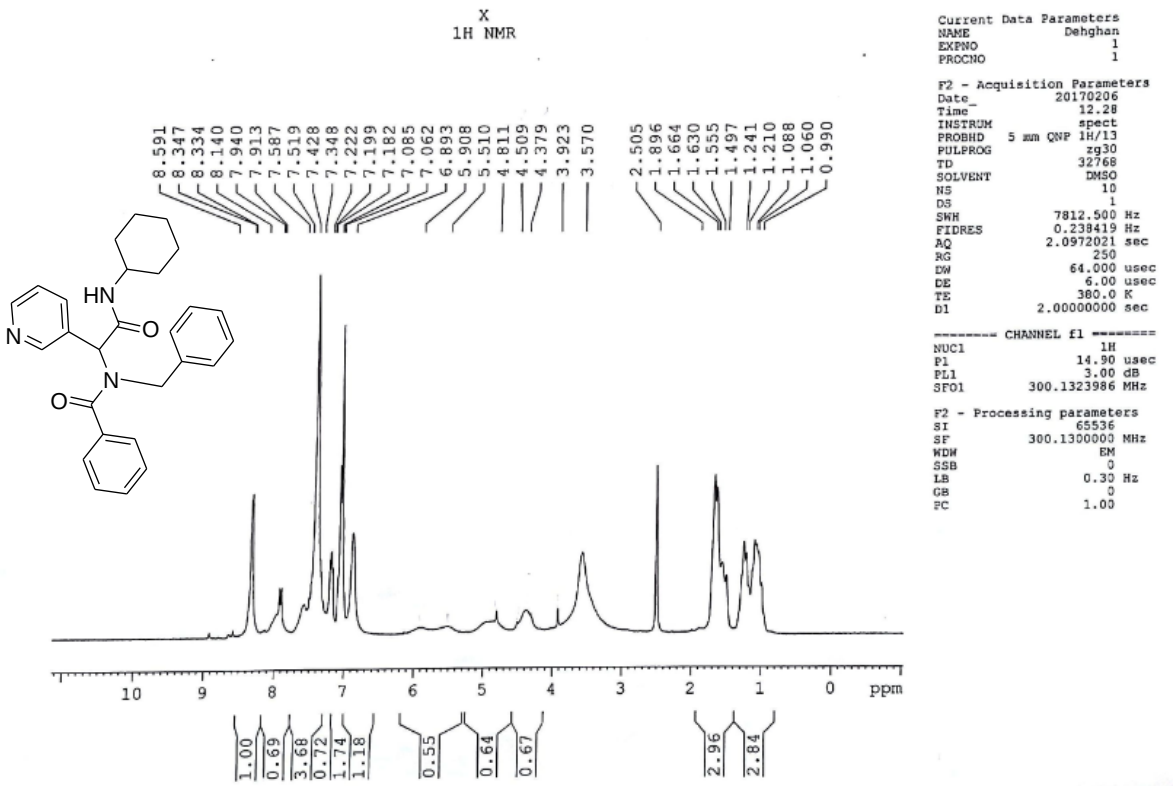


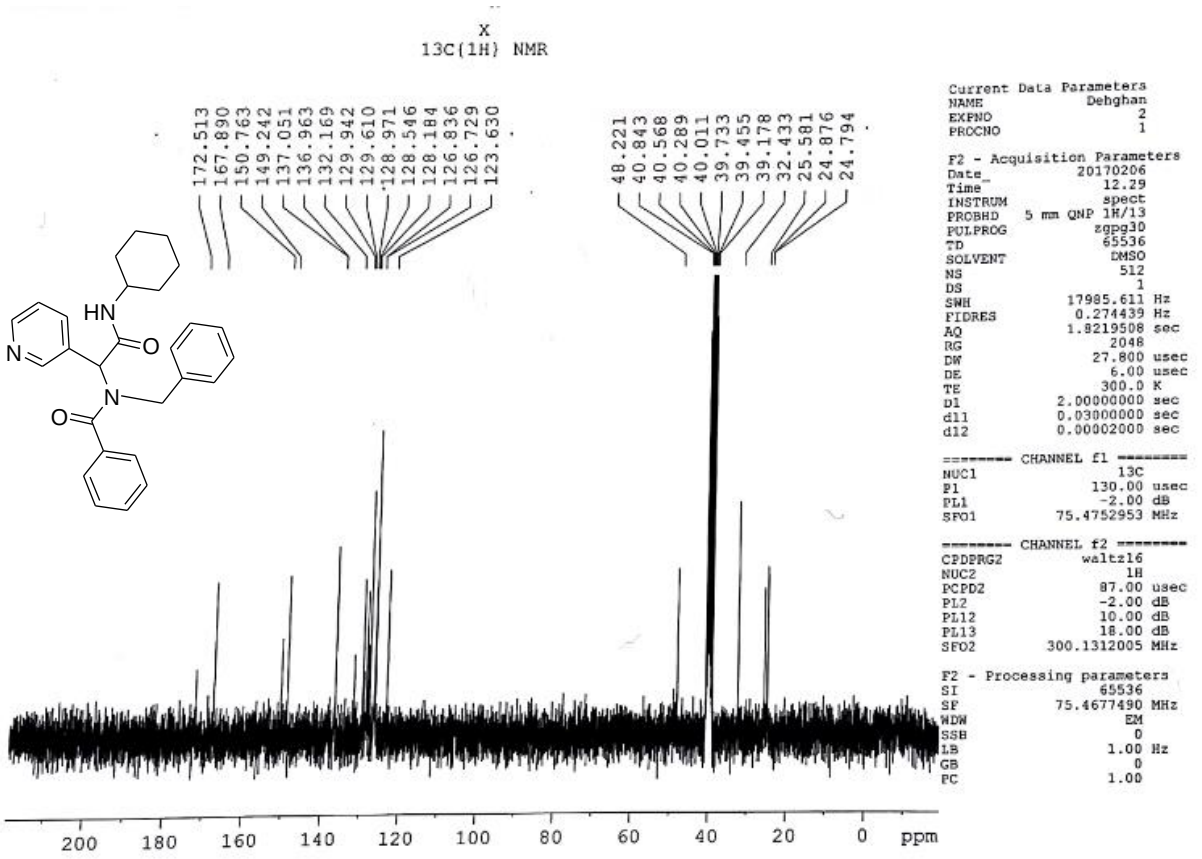
Figure 2S. The GC analysis for the product of benzyl alcohol oxidation (a), the mass spectra of benzaldehyde (b), benzyl alcohol (c) and benzoic acid (d).

3. Characterization of pyridine-contained dipeptide (N-benzyl-N-(2-(cyclohexylamino)-2-oxo-1-(pyridin-3-yl)ethyl)benzamide)

3.1. ^{1}H NMR spectrum



3.2. ^{13}C NMR spectrum



3.3. FT-IR spectrum