Electronic Supplementary Information

Bromide promoted hydrogenation of CO_2 to higher alcohols using Ru-Co homogeneous catalyst

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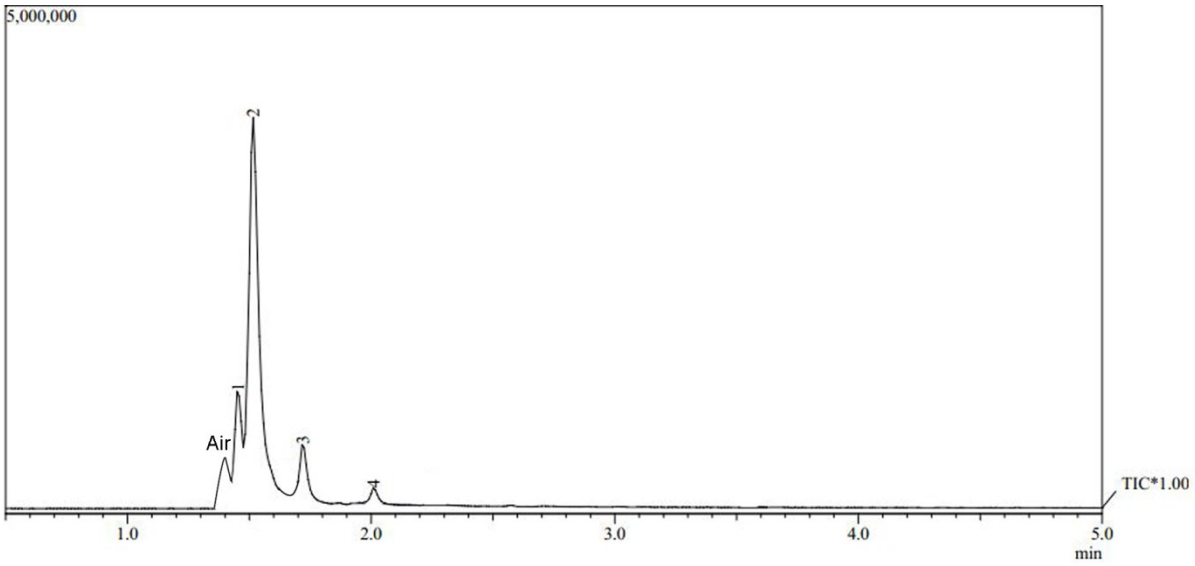
Figures



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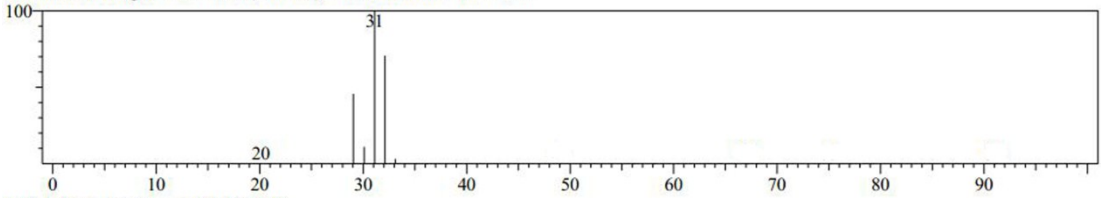

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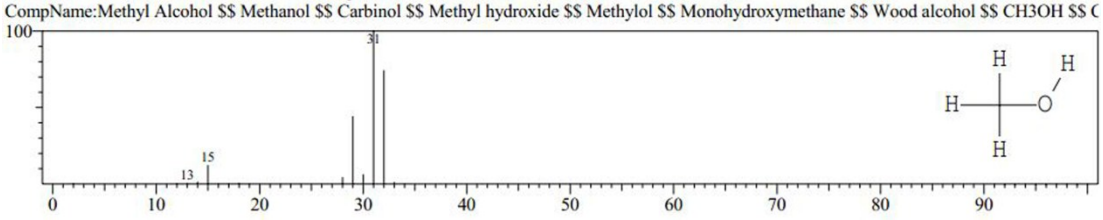


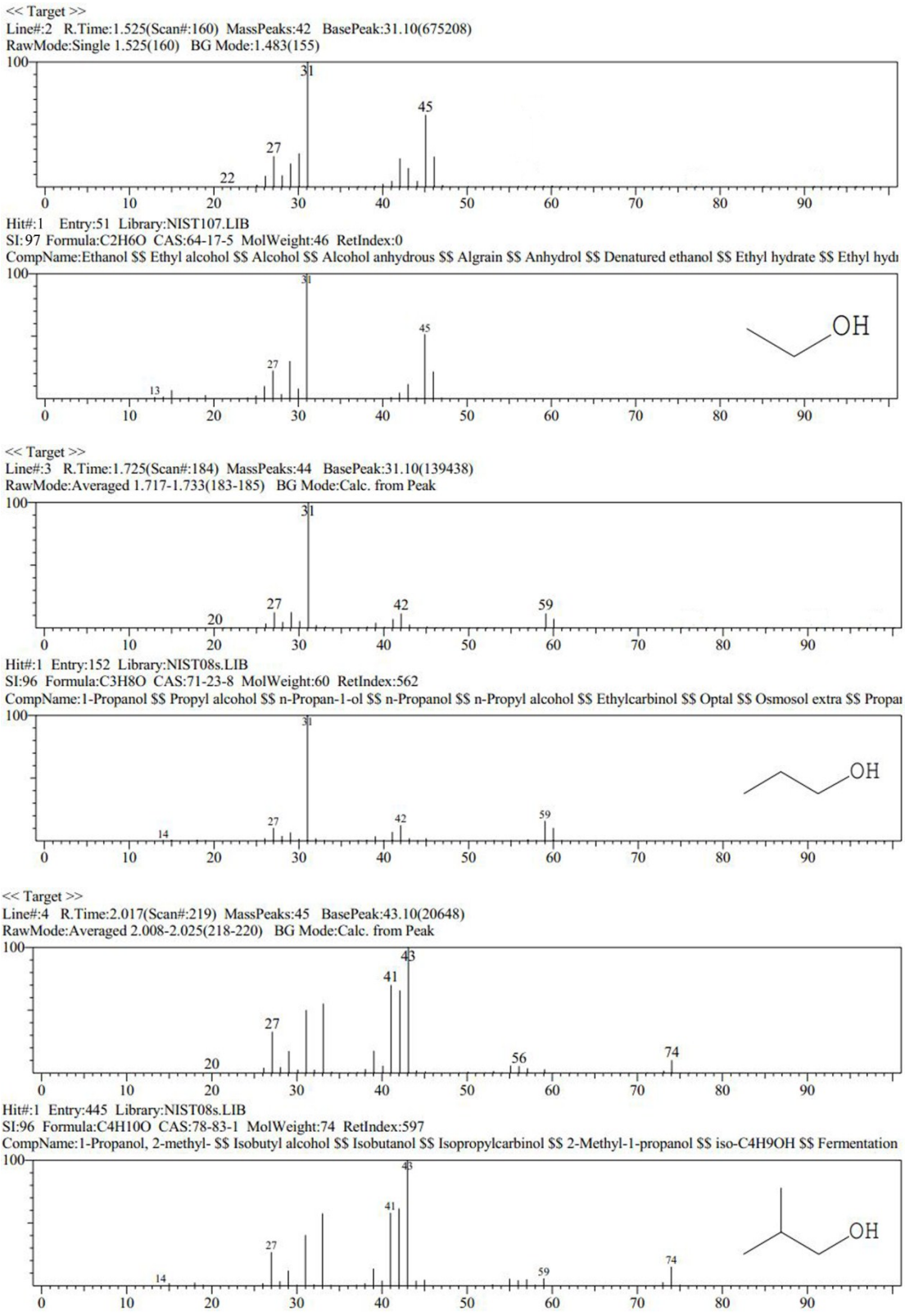


Fig. S1 GC-MS spectra of the products. Reaction conditions were the same as that of entry 1 in Table 1.

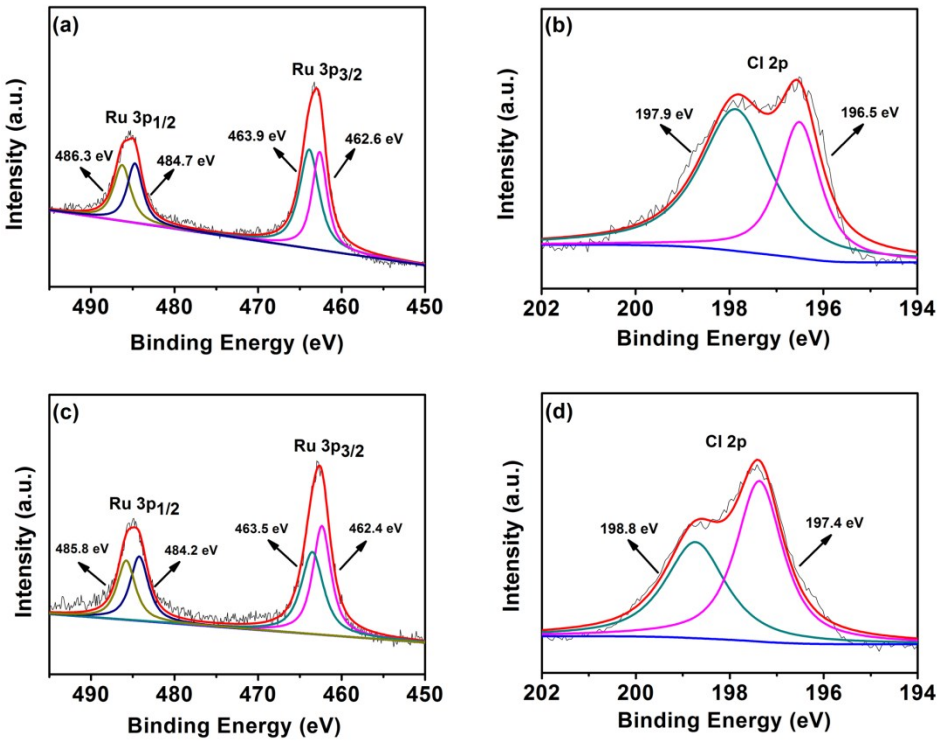
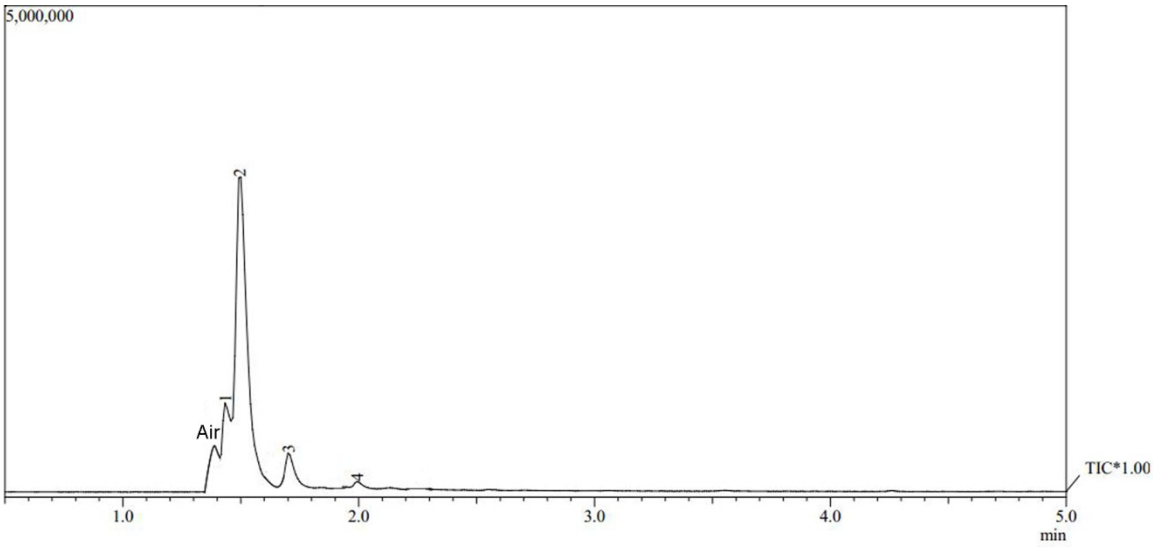


Fig. S2 XPS spectra of Ru (a), Cl (b) before the coordination of $Ru_3(CO)_{12}$ with PPNCl and Ru (c), Cl (d) after the coordination of $Ru_3(CO)_{12}$ with PPNCl.

Notes: The coordination of $Ru_3(CO)_{12}$ and PPNCl was conducted as follows: 8.5 mg $Ru_3(CO)_{12}$ (40 μmol Ru) was dissolved in 20 mL THF, 86.1 mg PPNCl (0.15 mmol) was dissolved in 20 mL methanol, the above solutions were mixed under stirring and the color of the mixed solution changed gradually from orange to bright yellow. After the mixture was stirred for 5 hrs at 40 ^{o}C, the solvent was removed using rotary evaporator. The precipitate was dried in vacuum at room temperature for 12 hrs before the XPS analysis. The X-ray photoelectron spectroscopy (XPS) data were obtained with an ESCA Lab 220i-XL electron spectrometer from VG Scientific using 300 W AlKα radiation. The base pressure was about 3×10^{-9} mbar. The binding energy was referenced to the C_{1s} line at 284.8 eV from adventitious carbon.



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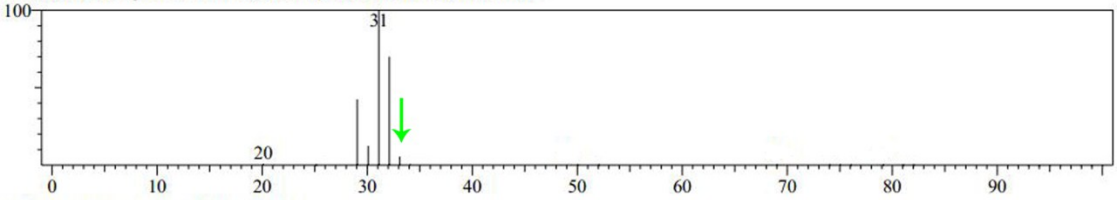

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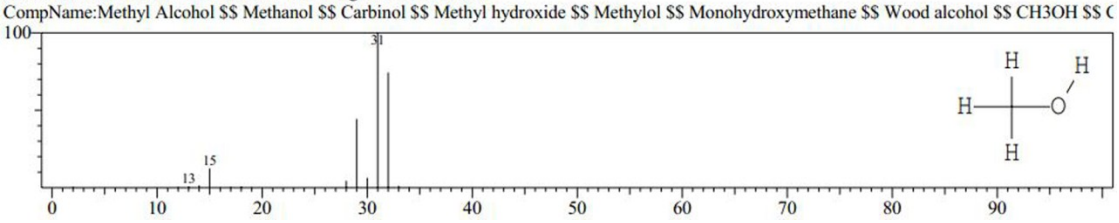
CompName:Methyl Alcohol $$ Methanol $$ Carbinol $$ Methyl hydroxide $$ Methylol $$ Monohydroxymethane $$ Wood alcohol $$ CH3OH $$ C



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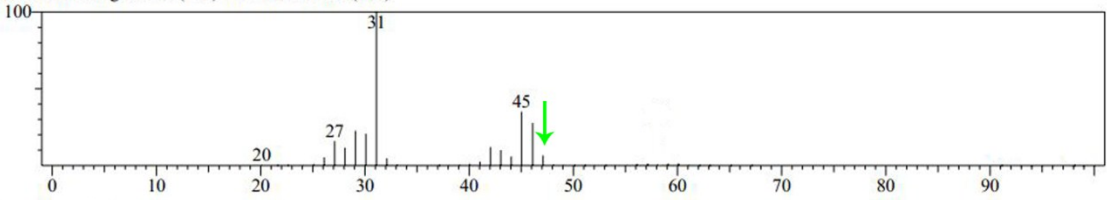

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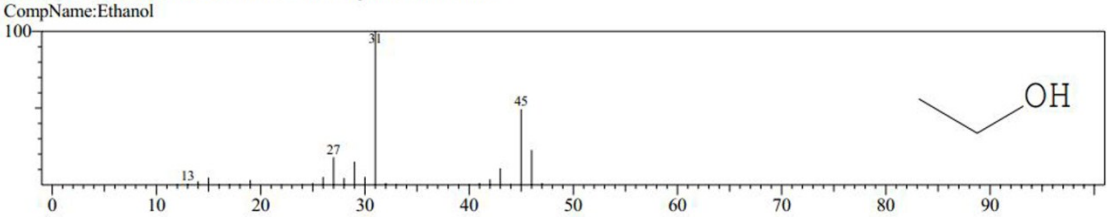
SI:84 Formula:C2H6O CAS:64-17-5 MolWeight:46 RetIndex:0

CompName:Ethanol



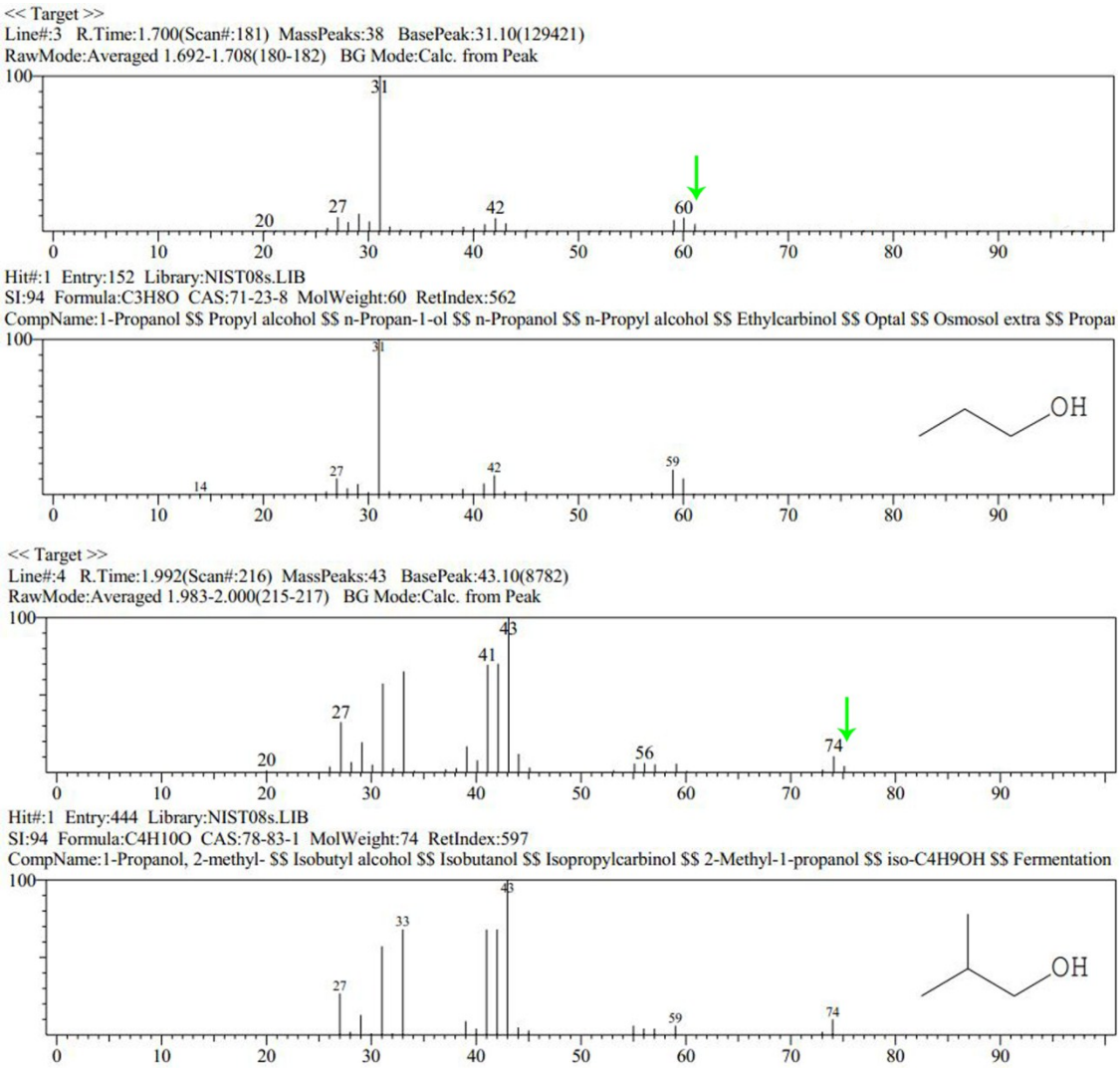
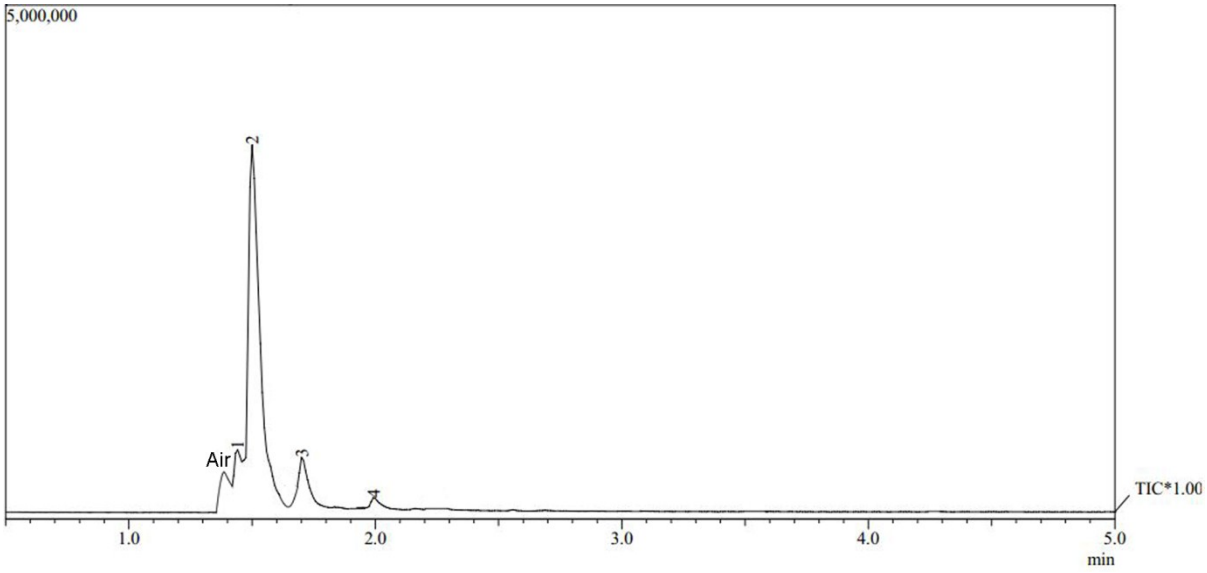


Fig. S3 GC-MS spectra of $^{13}CH_3OH$ tracer experiment. 60 μL $^{13}CH_3OH$ was used as tracer, other reaction conditions were the same as that of entry 1 in Table 1.



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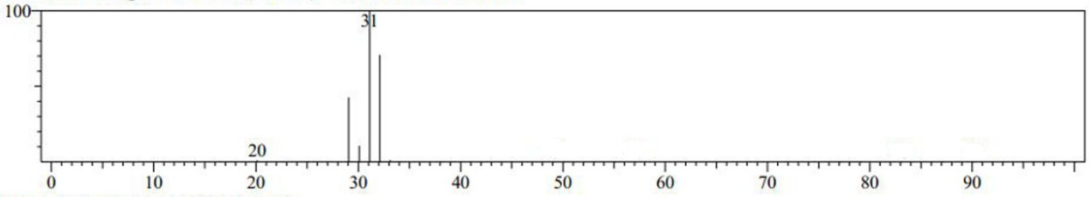

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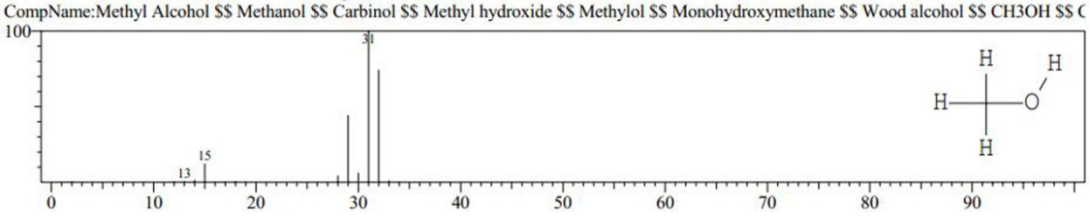
SI:97 Formula:CH4O CAS:67-56-1 MolWeight:32 RetIndex:0

CompName:Methyl Alcohol $$ Methanol $$ Carbinol $$ Methyl hydroxide $$ Methylol $$ Monohydroxymethane $$ Wood alcohol $$ CH3OH $$ C



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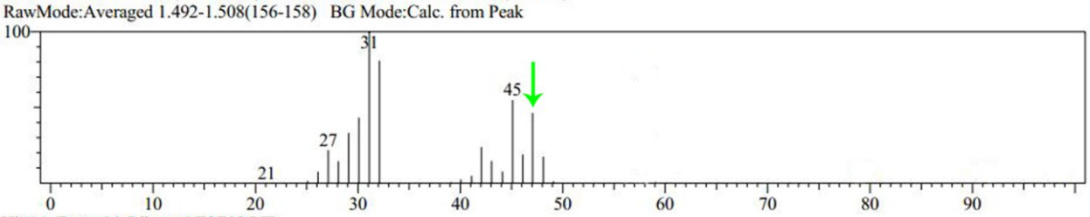

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SI: Formula:C2H6O CAS:64-17-5 MolWeight:46 RetIndex:463

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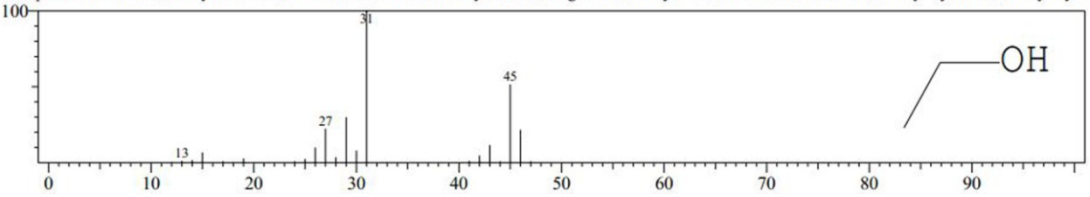

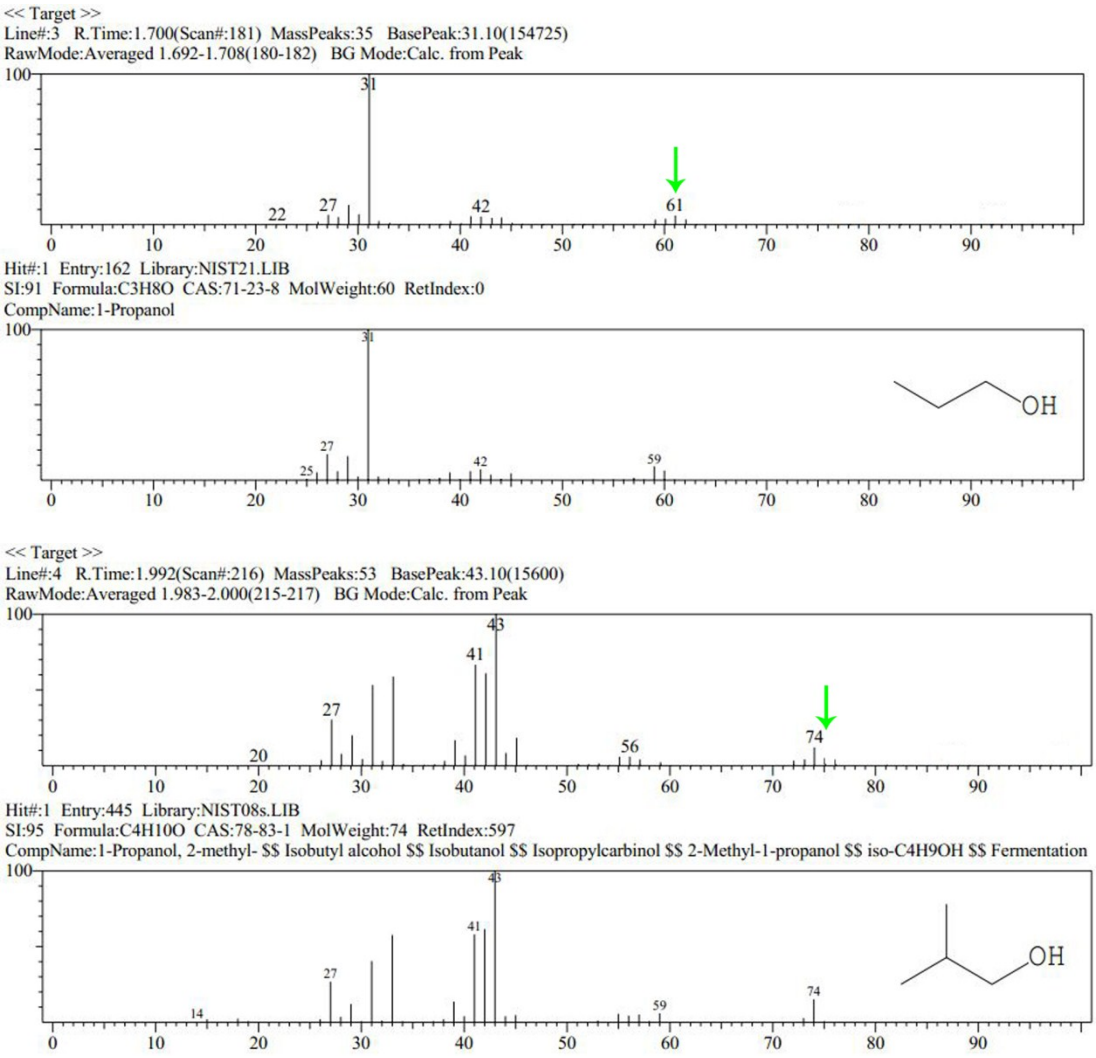

Fig. S4 GC-MS spectra of $^{13}C_2H_5OH$ tracer experiment. 25 μL $^{13}C_2H_5OH$ was used as tracer, other reaction conditions were the same as that of entry 1 in Table 1.

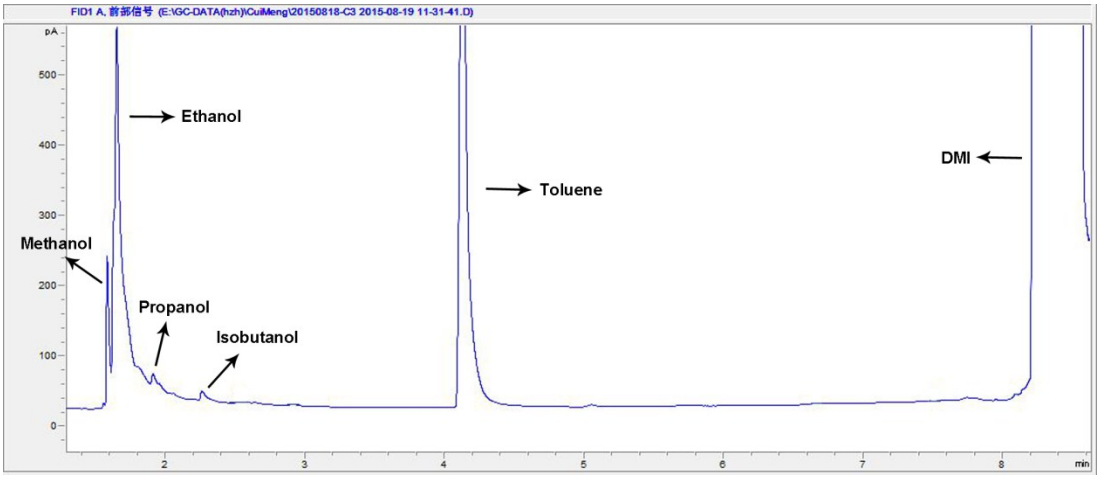

Fig. S5 Representative GC spectra of reaction solution after CO_2 hydrogenation with internal standard toluene. Reaction conditions were the same as that of entry 1 in Table 1.