Electronic Supplementary Material (ESI) for Physical Chemistry Chemical Physics.

Supplementary Information

Size-Dependent Catalytic Hydrogen Production via Methane Decomposition and Aromatization at a Low Temperature Using Co, Ni, Cu, Mo, and Ru Nanometals

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Figures S1–S14

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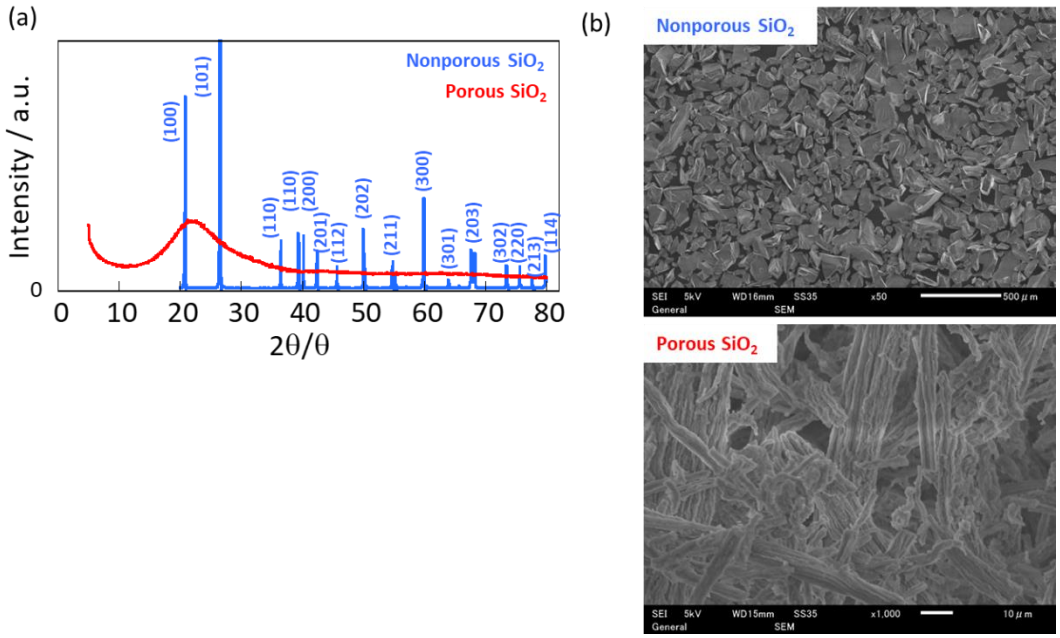

Figure S1. XRD patterns and (a) SEM images (b) of nonporous and porous SiO_2.

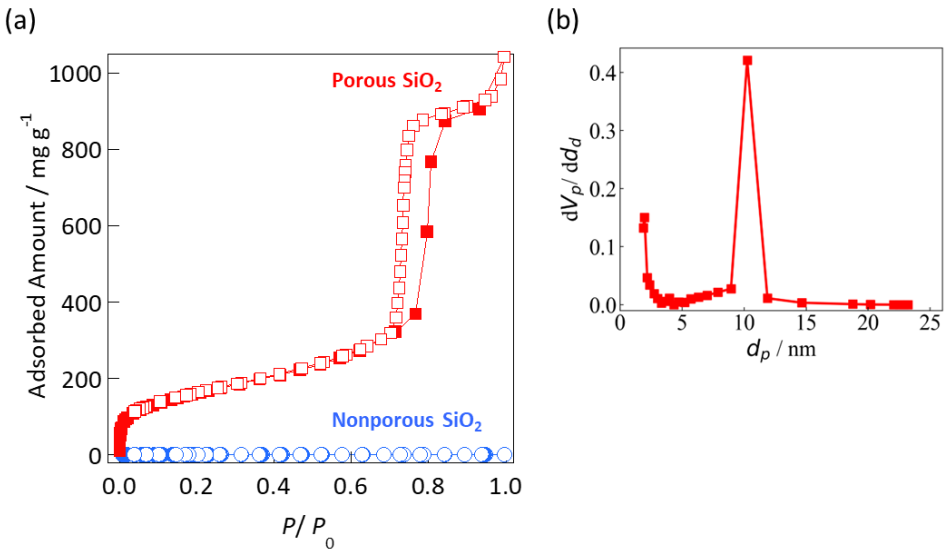

Figure S2. (a) N_2 adsorption isotherms at 77 K for nonporous and porous SiO_2. (b) Pore size distribution of porous SiO_2.

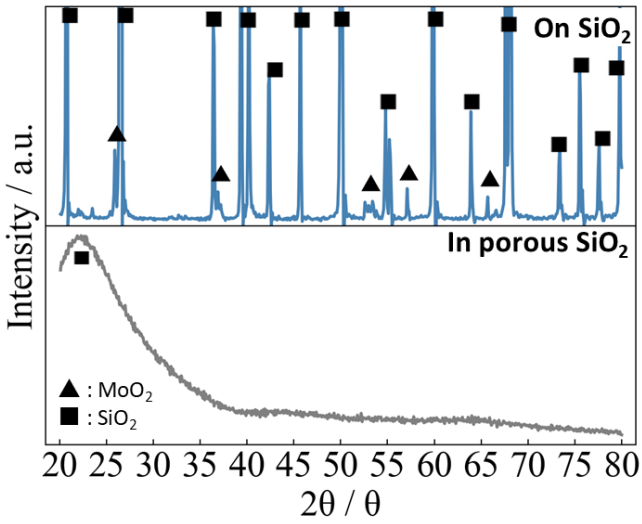

Figure S3. XRD patterns of the Mo nanocatalysts on nonporous SiO_2 (top) and porous SiO_2 (bottom) reduced at 800 K.

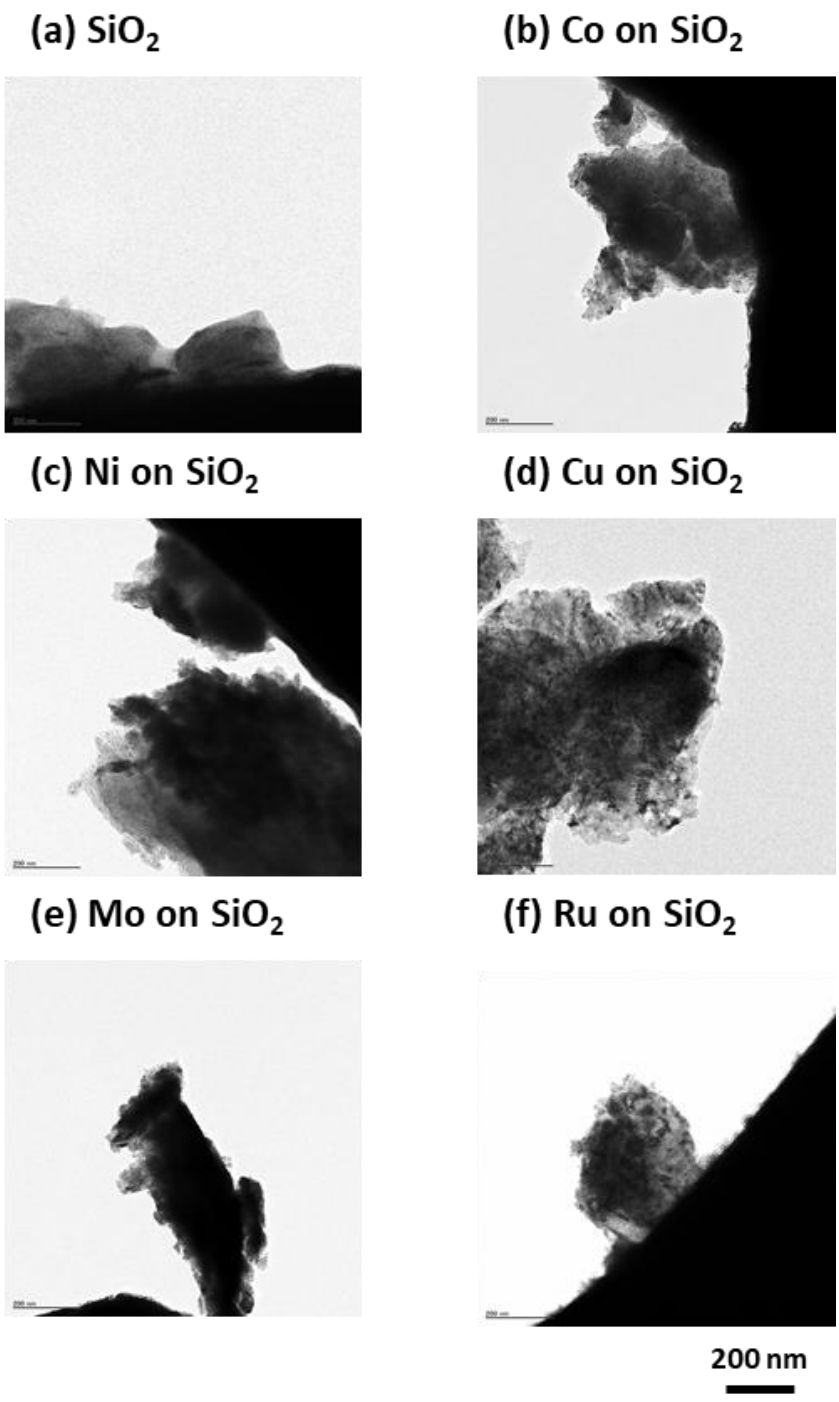

Figure S4. TEM images of nanocatalysts on nonporous SiO_2.

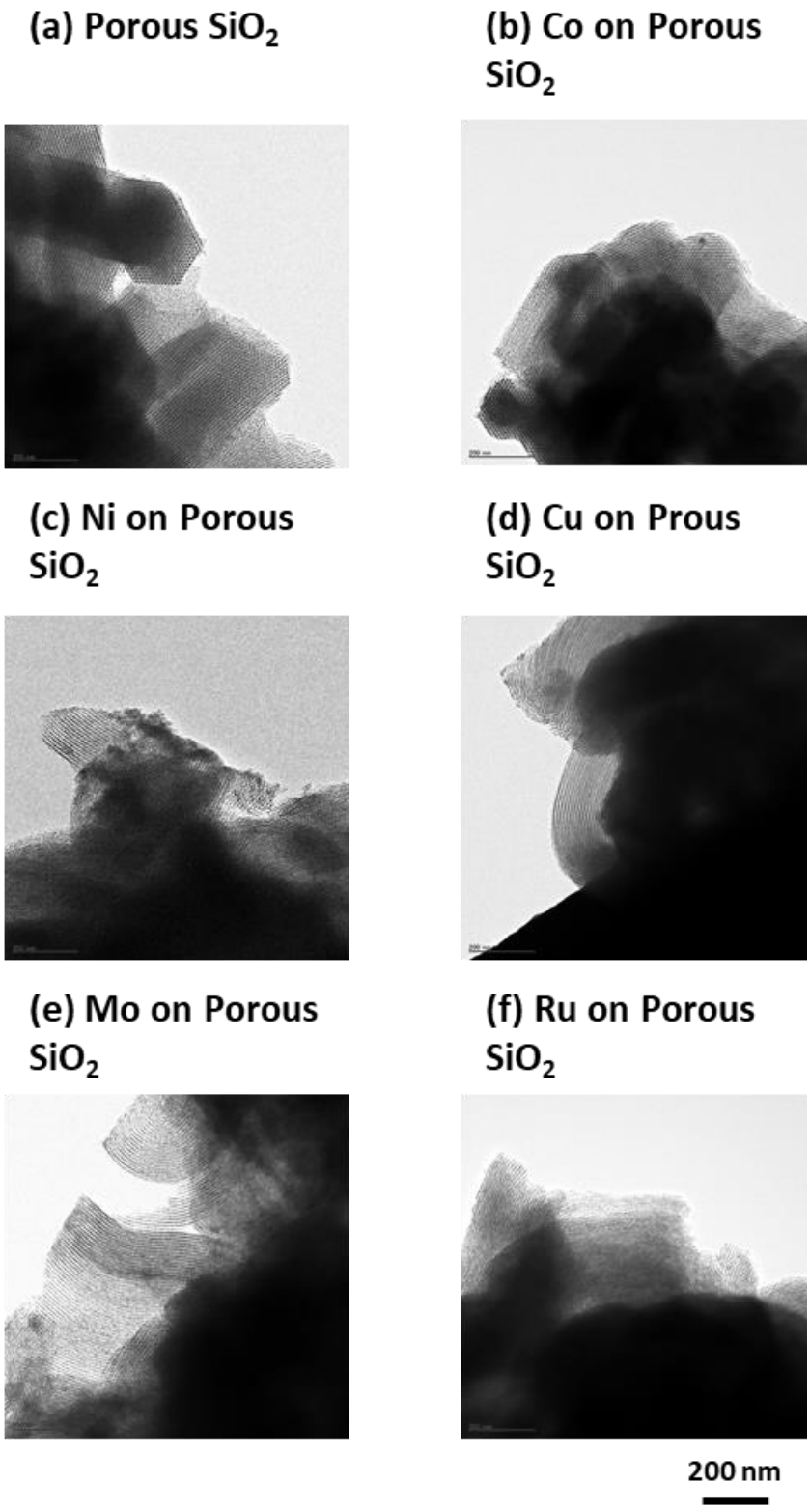

Figure S5. TEM images of nanocatalysts on porous SiO_2.

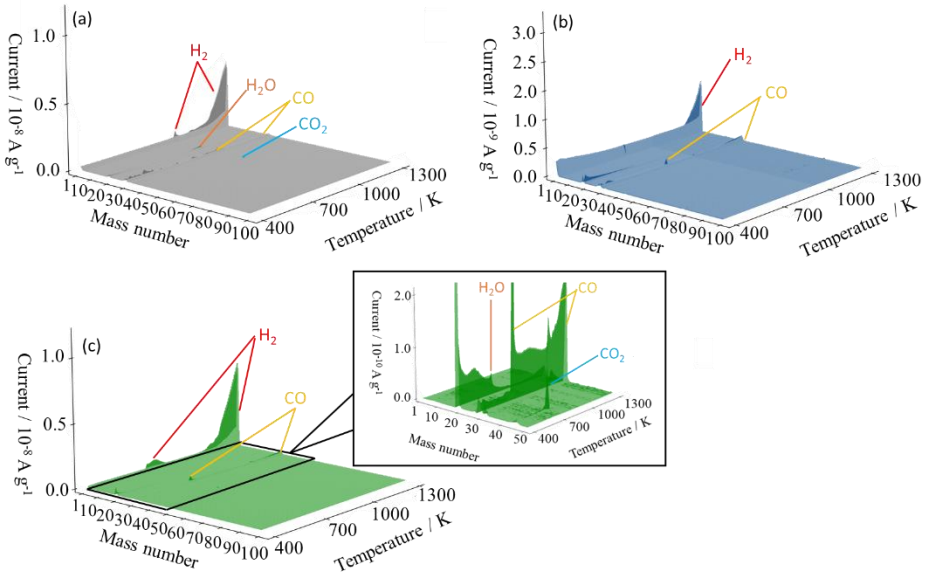

Figure S6. Mass spectroscopic peaks from 1 to 100 mass numbers for the Co catalysts in bulk (a), on SiO_2 (b), and in porous SiO_2 (c) within the range of 400–1300 K.

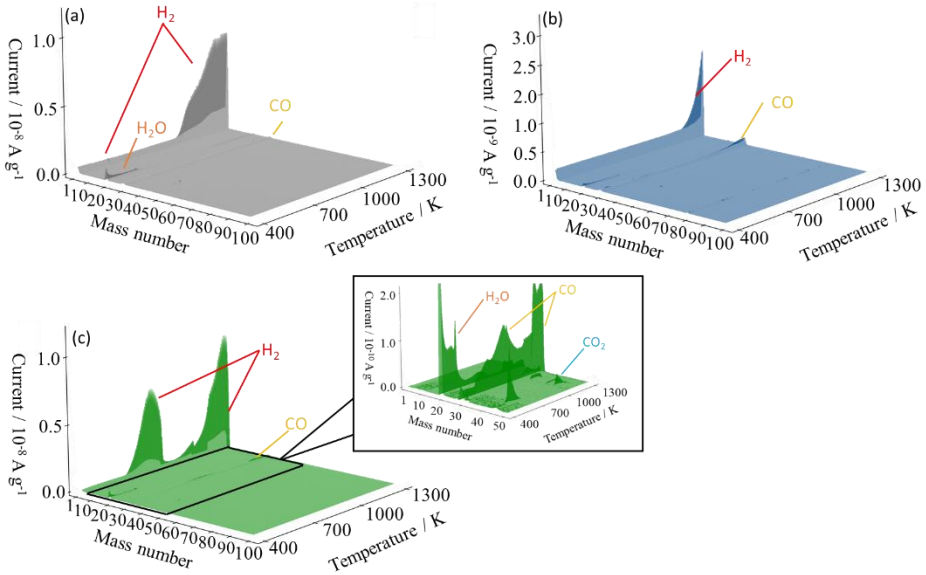

Figure S7. Mass spectroscopic peaks from 1 to 100 mass numbers for the Ni catalysts in bulk (a), on nonporous SiO_2 (b), and porous SiO_2 (c) within the range of 400–1300 K.

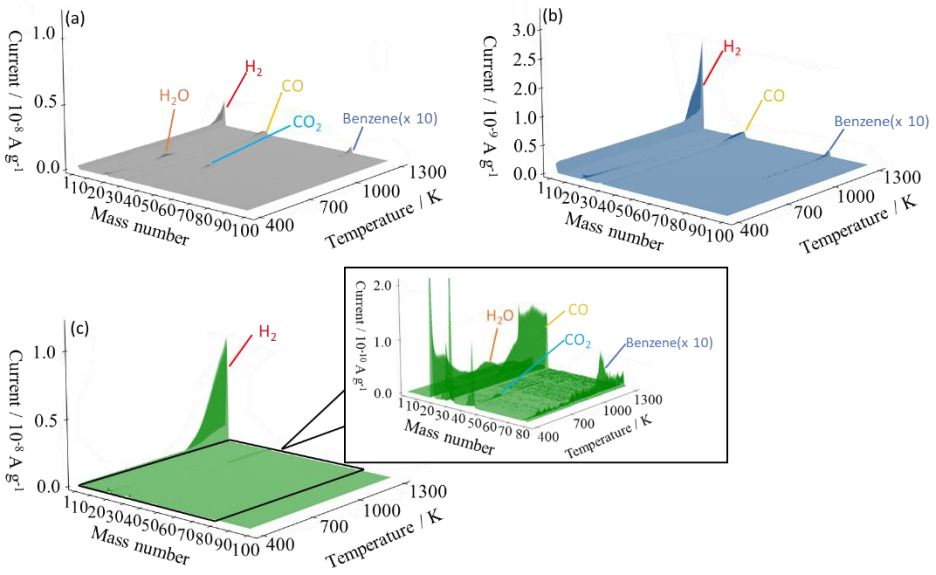

Figure S8. Mass spectroscopic peaks from 1 to 100 mass numbers for the Cu catalysts in bulk (a), on nonporous SiO_2 (b), and porous SiO_2 (c) within the range of 400–1300 K. The intensity of benzene was 10 times greater.

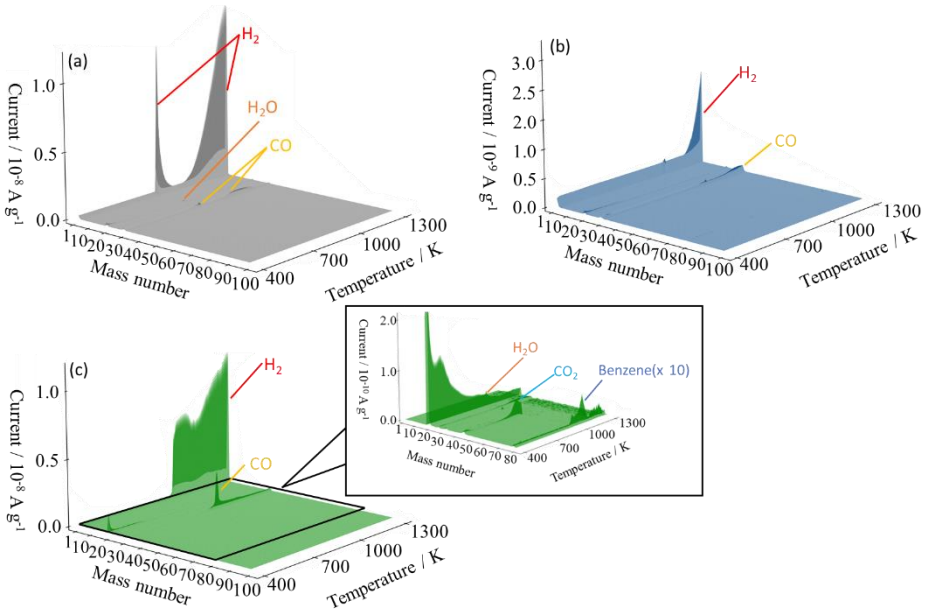

Figure S9. Mass spectroscopic peaks from 1 to 100 mass numbers for the Mo catalysts in bulk (a), on nonporous SiO_2 (b), and porous SiO_2 (c) within the range of 400–1300 K.

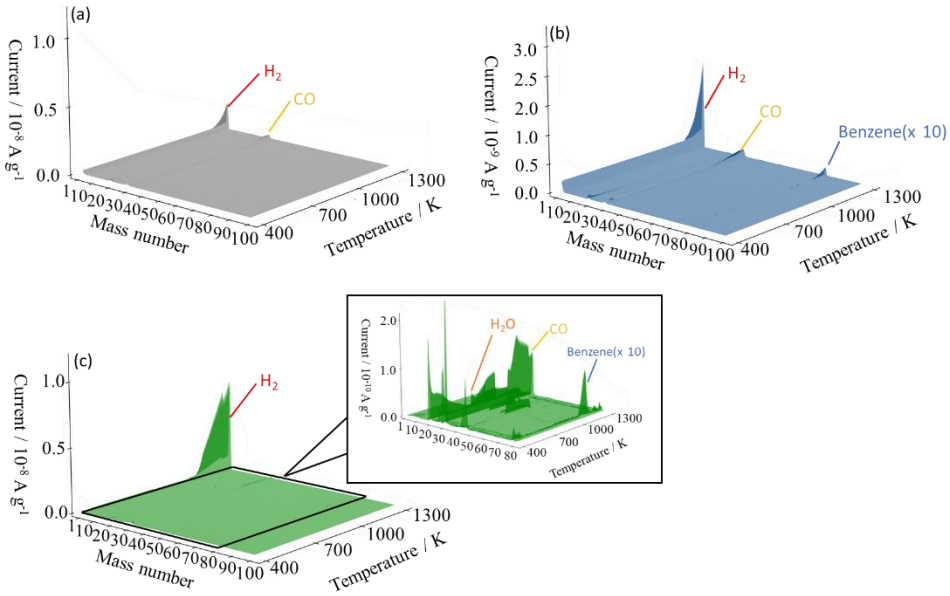

Figure S10. Mass spectroscopic peaks from 1 to 100 mass numbers for the Ru catalysts in bulk (a), on nonporous SiO_2 (b), and porous SiO_2 (c) within the range of 400–1300 K.

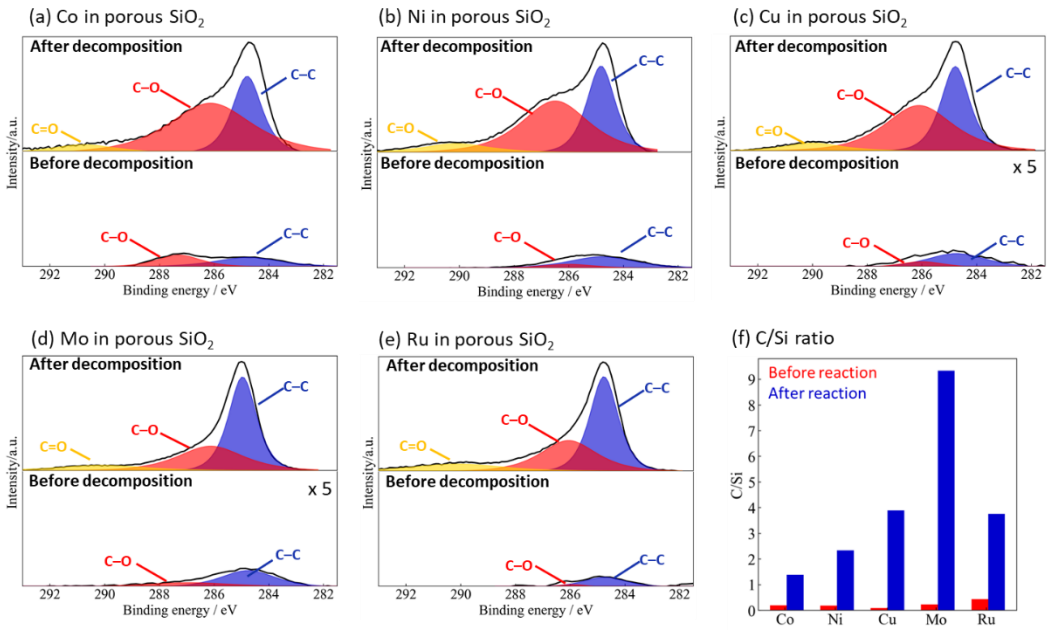

Figure S11. XPS spectra of C1s results for spent catalysts in the Co (a), Ni (b), Cu (c), Mo (d), and Ru (e) nanocatalysts on porous SiO_2.

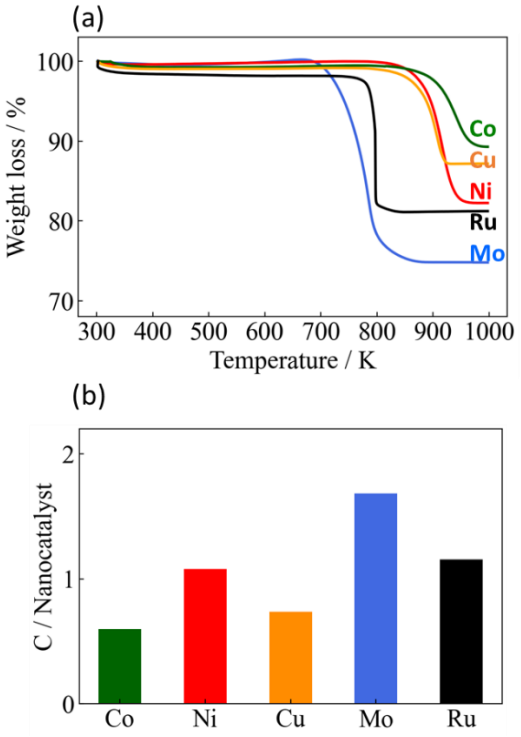

Figure S12. (a) Thermogravimetric analyses of nanocatalysts after methane decomposition reactions in O_2 atmosphere. (b) Mole ratio of C against nanocatalyst.

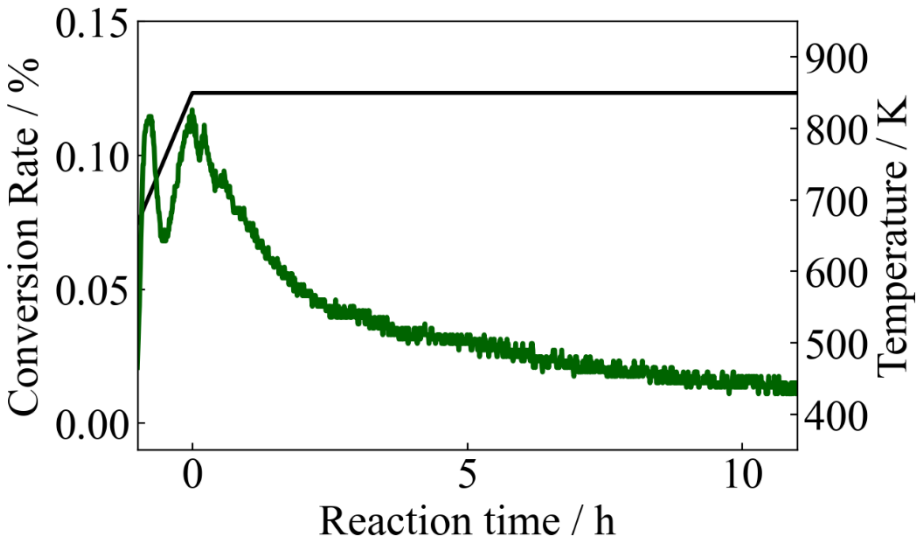

Figure S13. Isothermal methane decomposition using the Mo bulk nanocatalyst at 860 K.

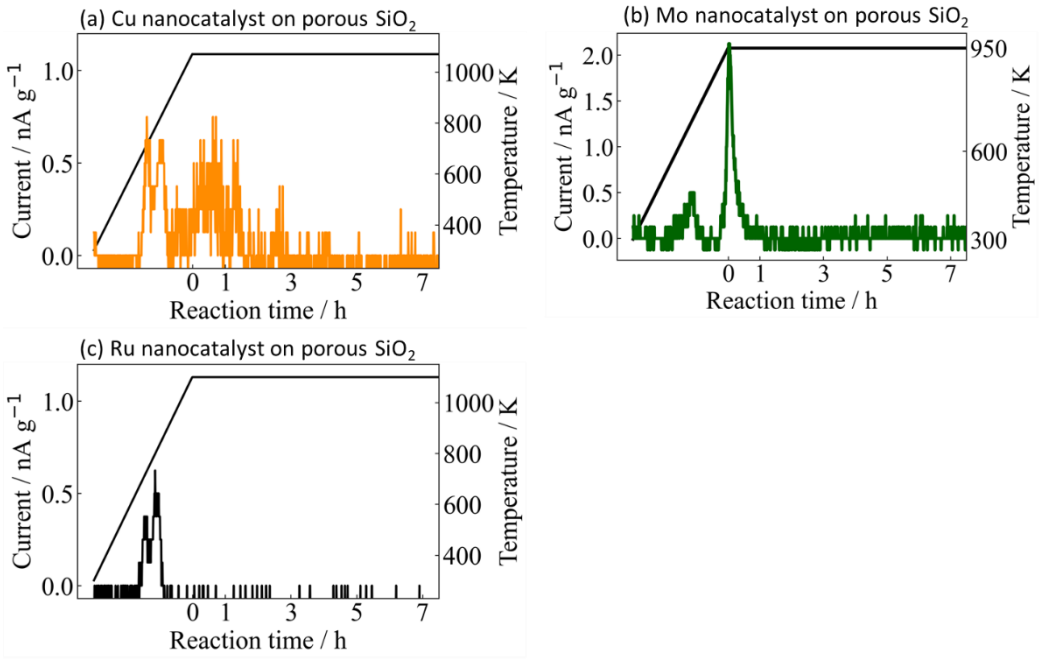

Figure S14. Isothermal methane aromatization to benzene using the Cu nanocatalyst at 1070 K (a), Mo nanocatalyst at 950 K (b), and Ru nanocatalyst at 1100 K (c).