

Electronic Supplementary Information

Energy efficient and intermittently variable ammonia synthesis over mesoporous carbon-supported Cs-Ru nanocatalysts

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Table S1. TPR-MS data of the prepared Cs-Ru catalysts.

Catalysts	α_1 (°C)	α_2 (°C)	α_3 (°C)	α_4 (°C)	β_1 (°C)	β_2 (°C)	β_3 (°C)	β_4 (°C)	β_5 (°C)	β_6 (°C)	γ_1 (°C)
Figures	Fig. 6(A)	Fig. 6(D)	Fig. 6(D)	Fig. 6(F)	Fig. 6(B)	Fig. 6(B)	Fig. 6(C)	Fig. 6(C)	Fig. 6(E)	Fig. 6(FD)	Fig. 6(E)
m/z	2 (H ₂)	18 (H ₂ O)	18 (H ₂ O)	44 (CO ₂)	2 (H ₂)	2 (H ₂)	15 (CH ₃)	15 (CH ₃)	28 (CO)	44 (CO ₂)	28 (CO)
2.5Cs-10Ru/AC	132	87	137	124	396	437	415	443	389	304	701
2.5Cs-10Ru/MPC-15	120	90	124	112	378	415	400	421	379	300	708
2.5Cs-10Ru/MPC-18	133	90	137	116	375	415	397	421	374	325	723
2.5Cs-10Ru/MPC-21	138	90	143	160	390	443	405	473	393	327	774

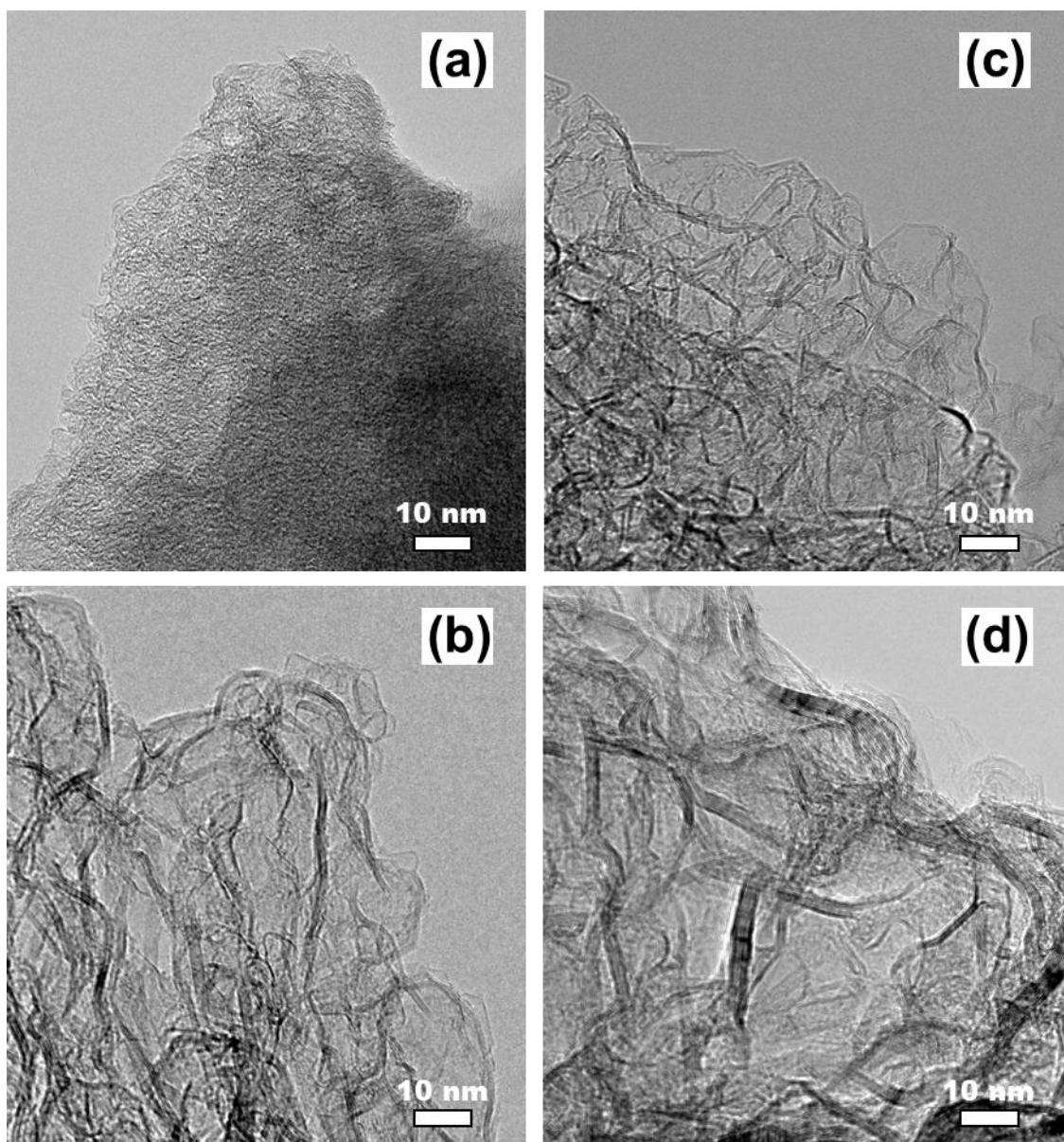


Figure S1. HRTEM images of carbon supports (a) AC, (b) MPC-15, (c) MPC-18, and (d) MPC-21.

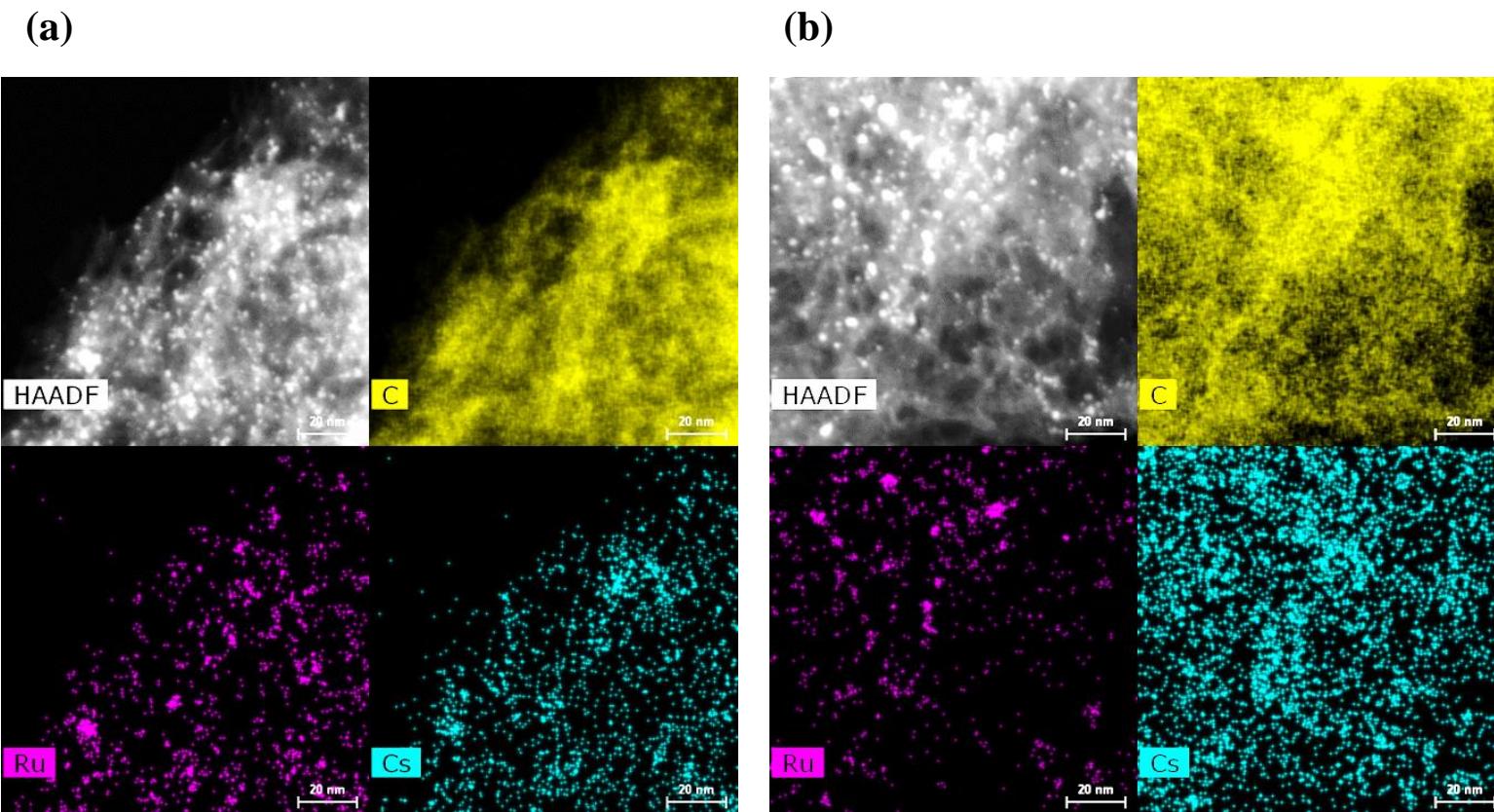


Figure S2. HAADF-STEM images of 2.5Cs-10Ru/MPC-15 catalysts. (a) Fresh and (b) used samples.

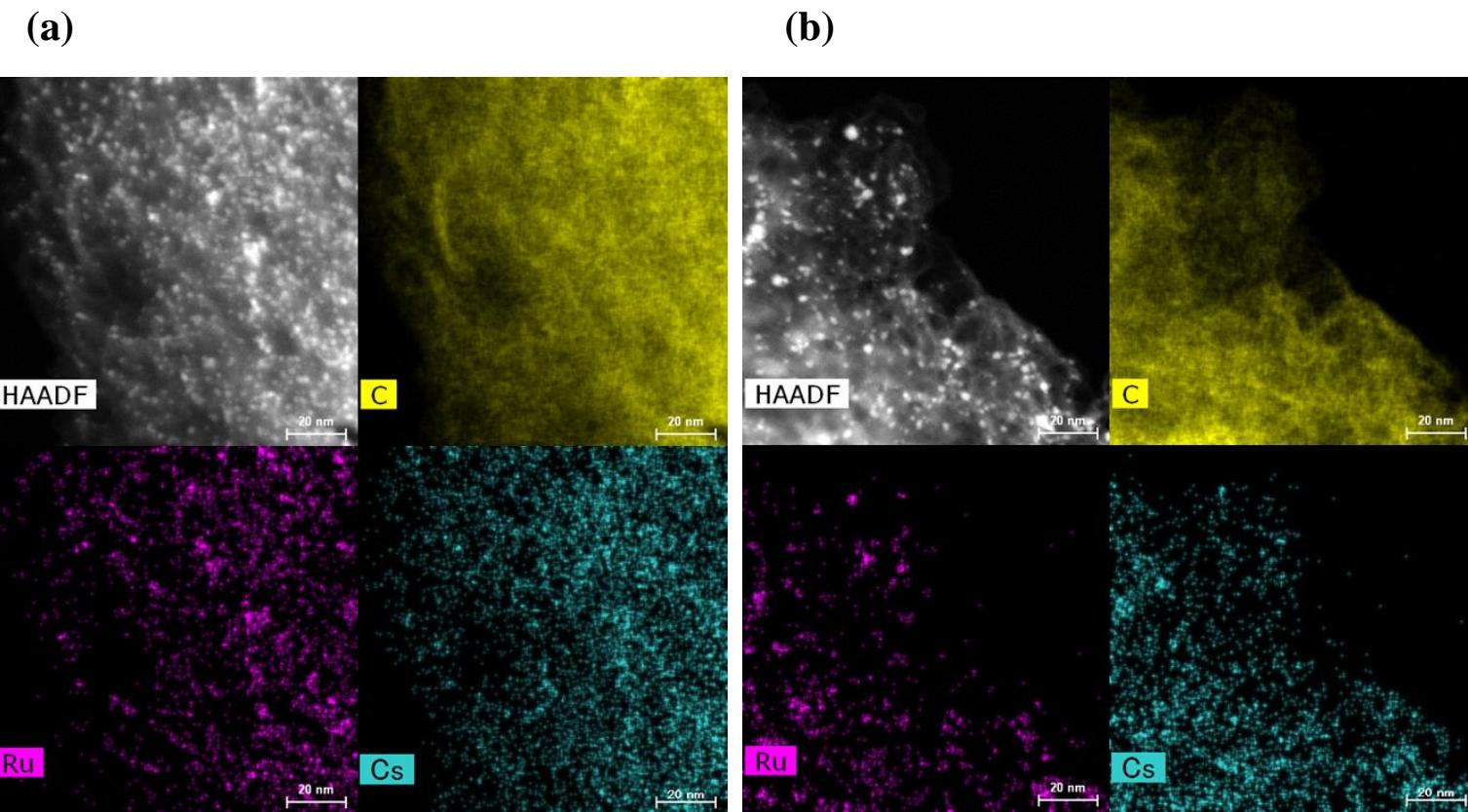


Figure S3. HAADF-STEM images of 2.5Cs-10Ru/MPC-18 catalysts. (a) Fresh and (b) used samples.

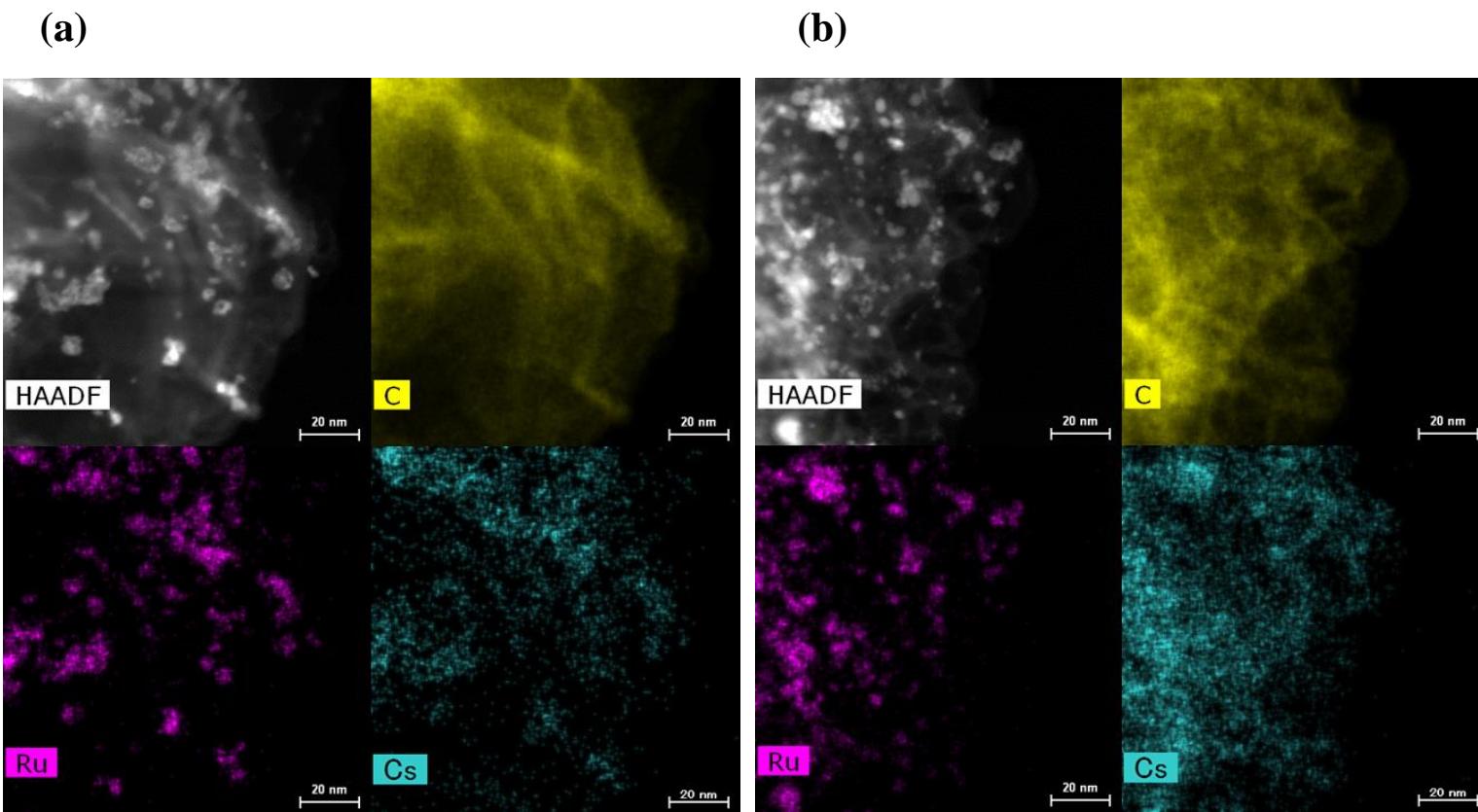


Figure S4. HAADF-STEM images of 2.5Cs-10Ru/MPC-21 catalysts. (a) Fresh and (b) used samples.

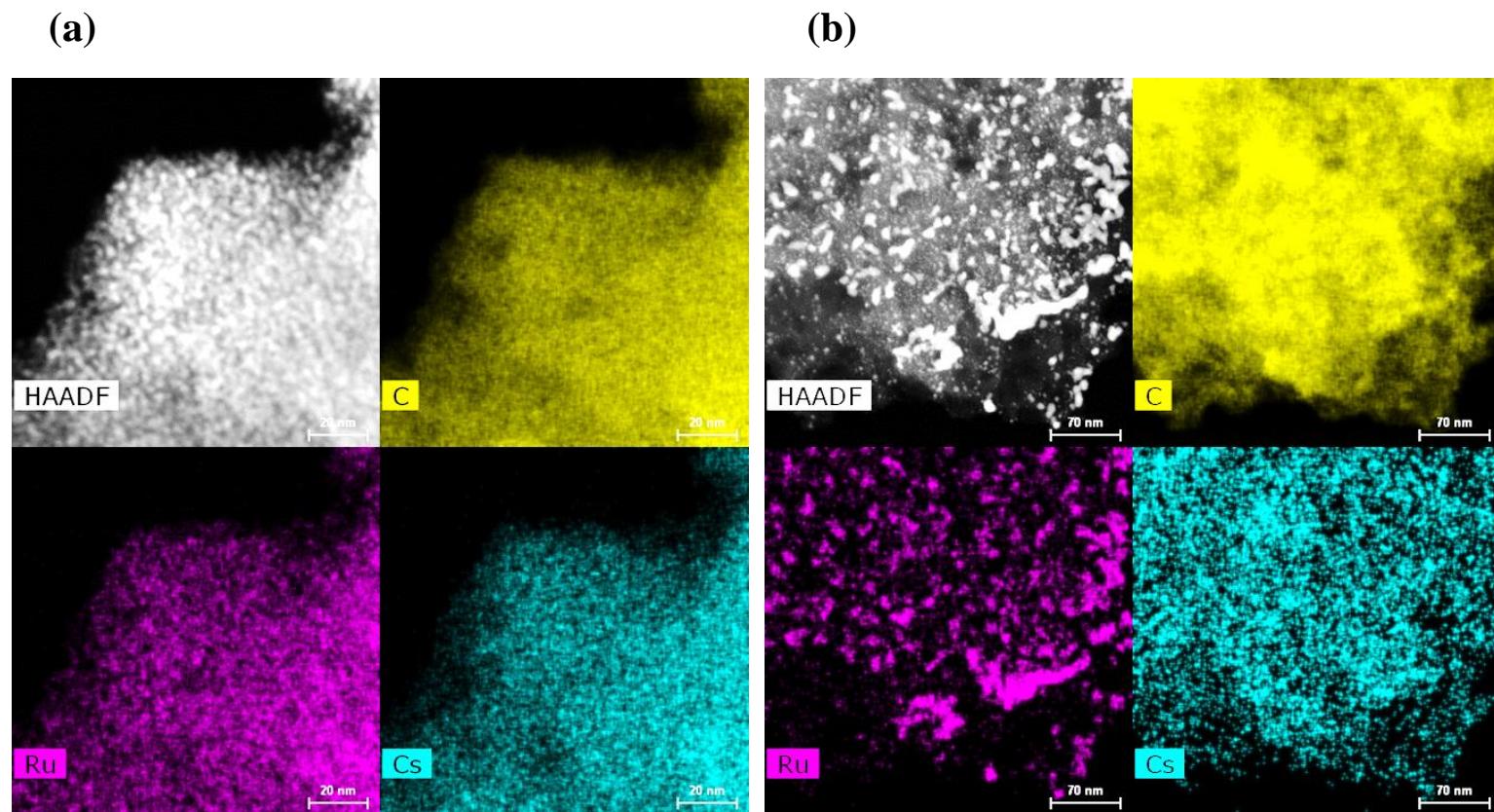


Figure S5. HAADF-STEM images of 2.5Cs-10Ru/AC catalysts. (a) Fresh and (b) used samples.

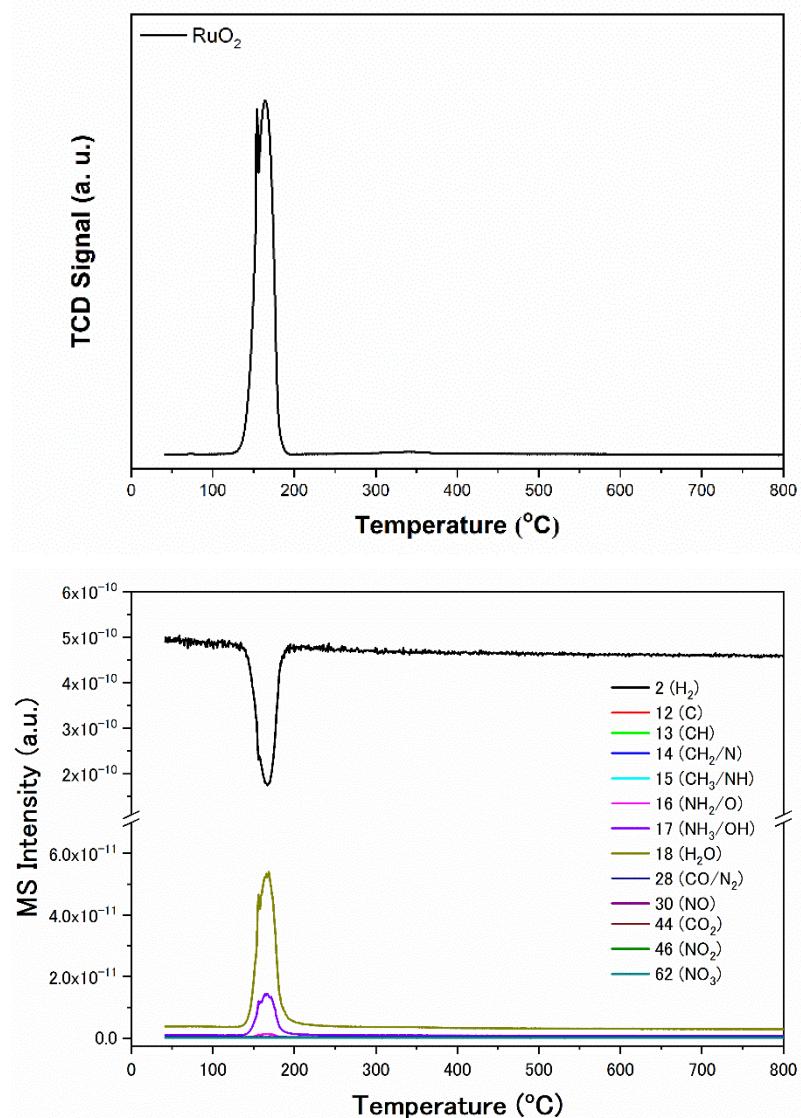


Figure S6. TPR-TCD and TPR-MS profiles of RuO₂.

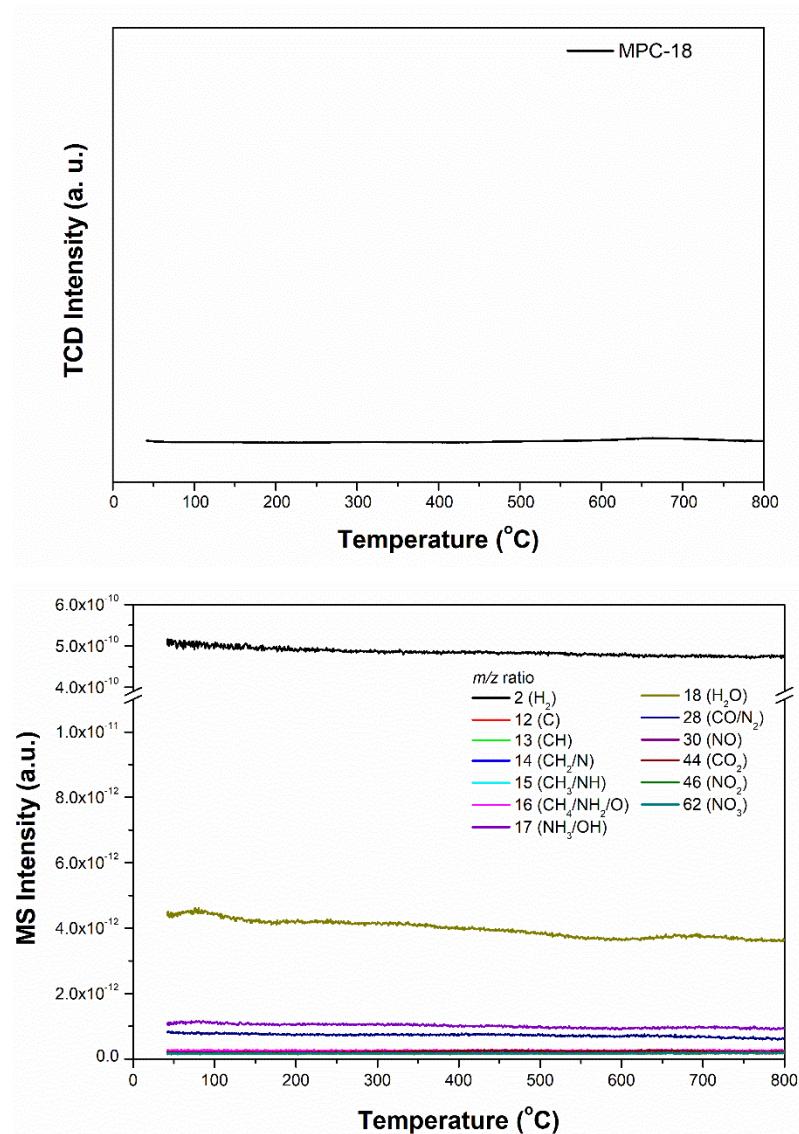


Figure S7. TPR-TCD and TPR-MS profiles of MPC-18.

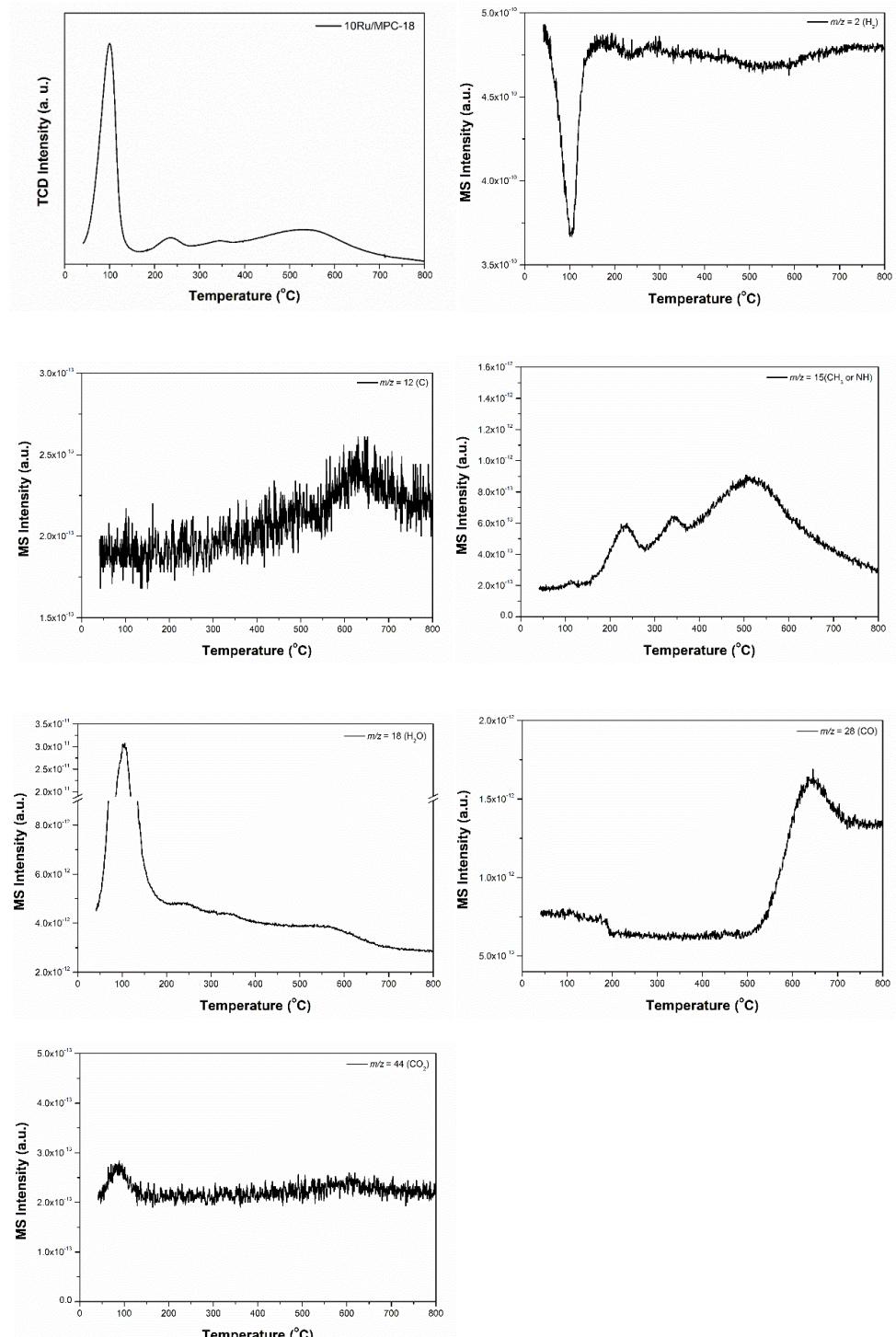


Figure S8. TPR-TCD and TPR-MS profiles of 10Ru/MPC-18 obtained by the dispersion of MPC-18 (1 g) in 70 mL of ethanol (50%, v/v) containing 0.31 g of nitrosylruthenium(III) nitrate ($\text{Ru}(\text{NO})(\text{NO}_3)_3$) and slowly heating to around 70–80 °C until the solvent completely evaporated. This was followed by calcination at 400 °C for 3 h in N_2 at a ramp rate of 5 °C min⁻¹.

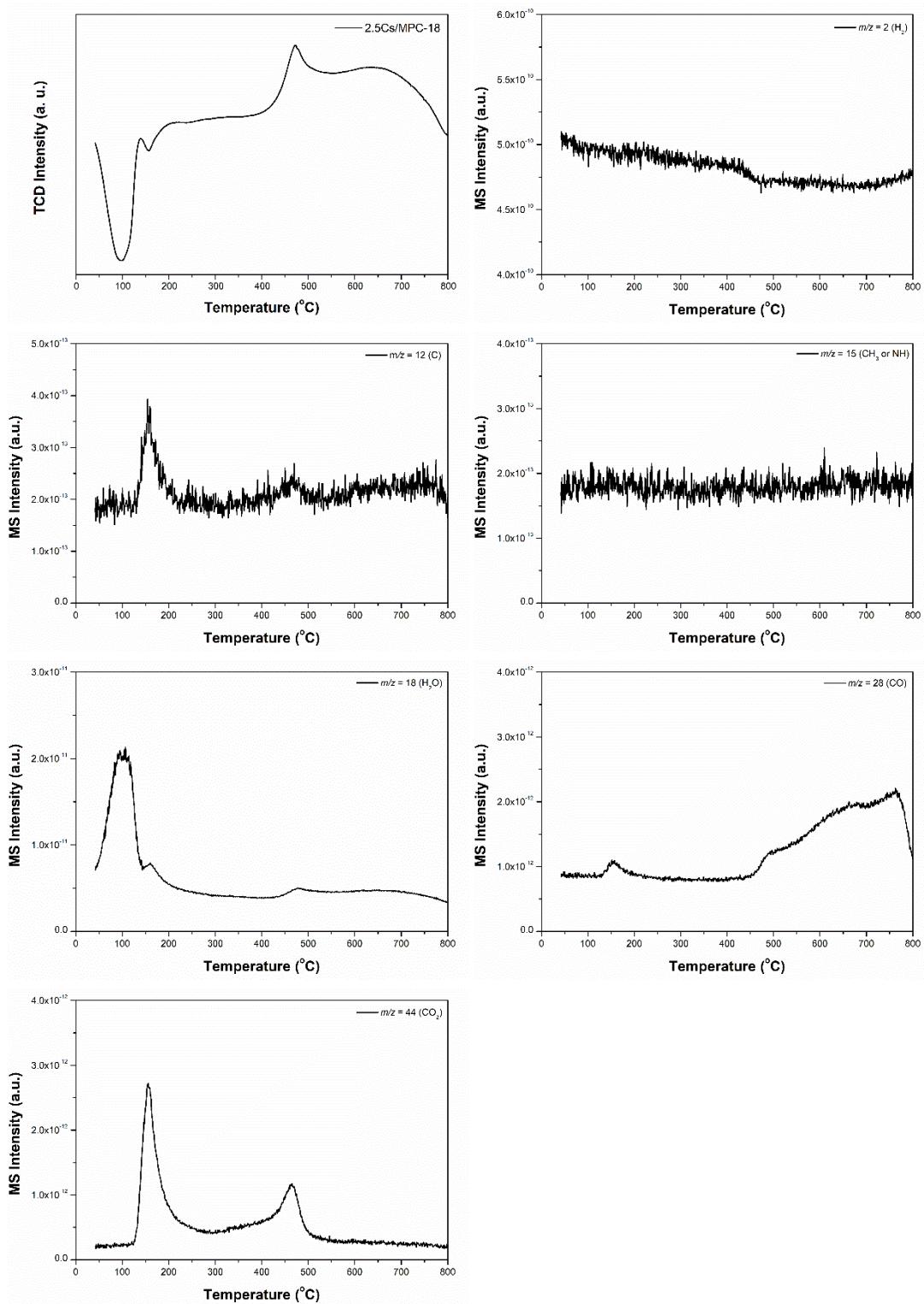


Figure S9. TPR-TCD and TPR-MS profiles of 2.5Cs/MPC-18 obtained by the dispersion of MPC-18 (1 g) in 70 mL of ethanol (50%, v/v) containing a 0.40 g of cesium carbonate ($Cs_2(CO_3)$) and slowly heating to around 70–80 °C until the solvent completely evaporated.

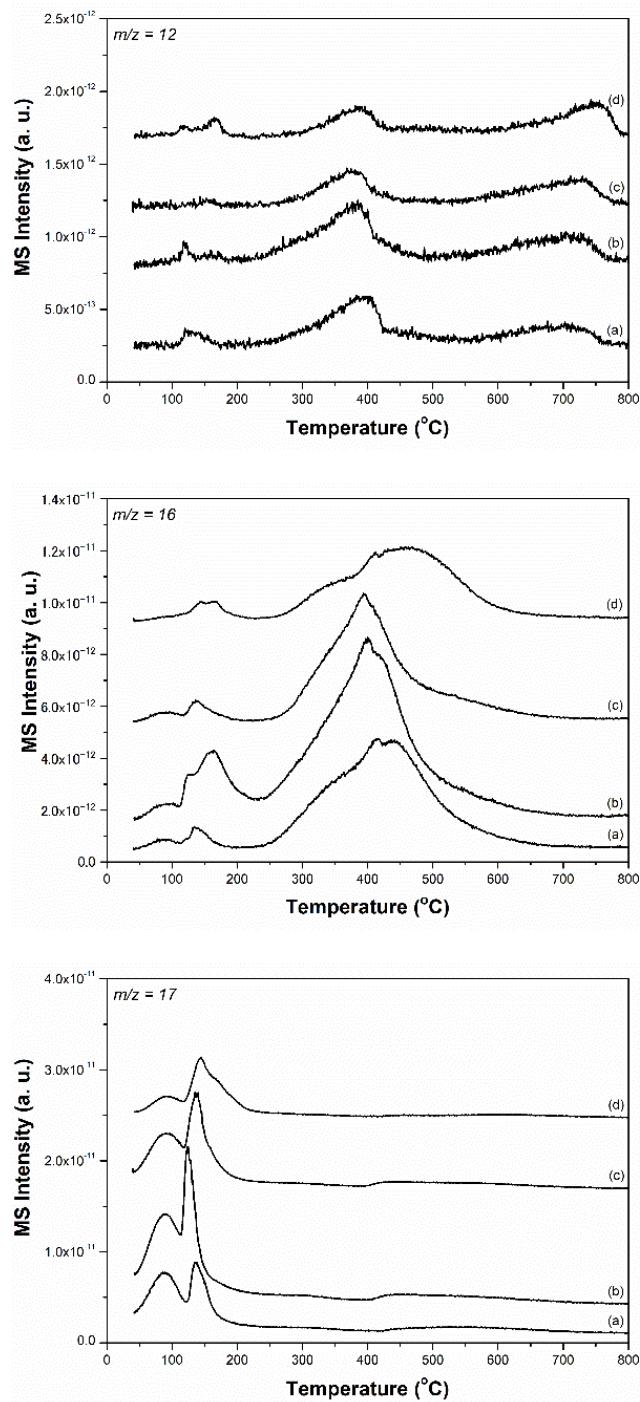


Figure S10. TPR-MS profiles of freshly prepared catalysts (a) 2.5Cs-10Ru/AC, (b) 2.5Cs-10Ru/MPC-15, (c) 2.5Cs-10Ru/MPC-18, and (d) 2.5Cs-10Ru/MPC-21.

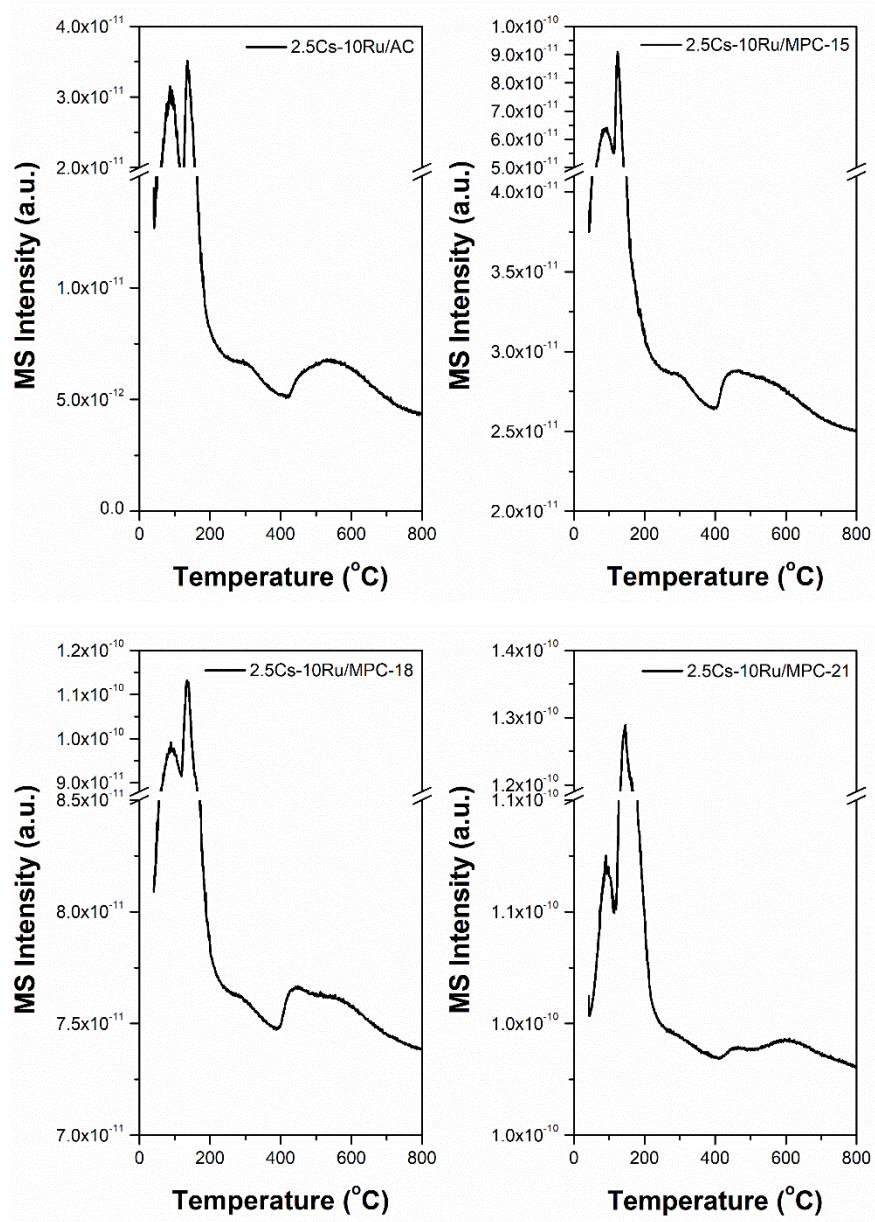


Figure S11. TPR-MS profiles ($m/z = 18$) of freshly prepared Cs-Ru catalysts.

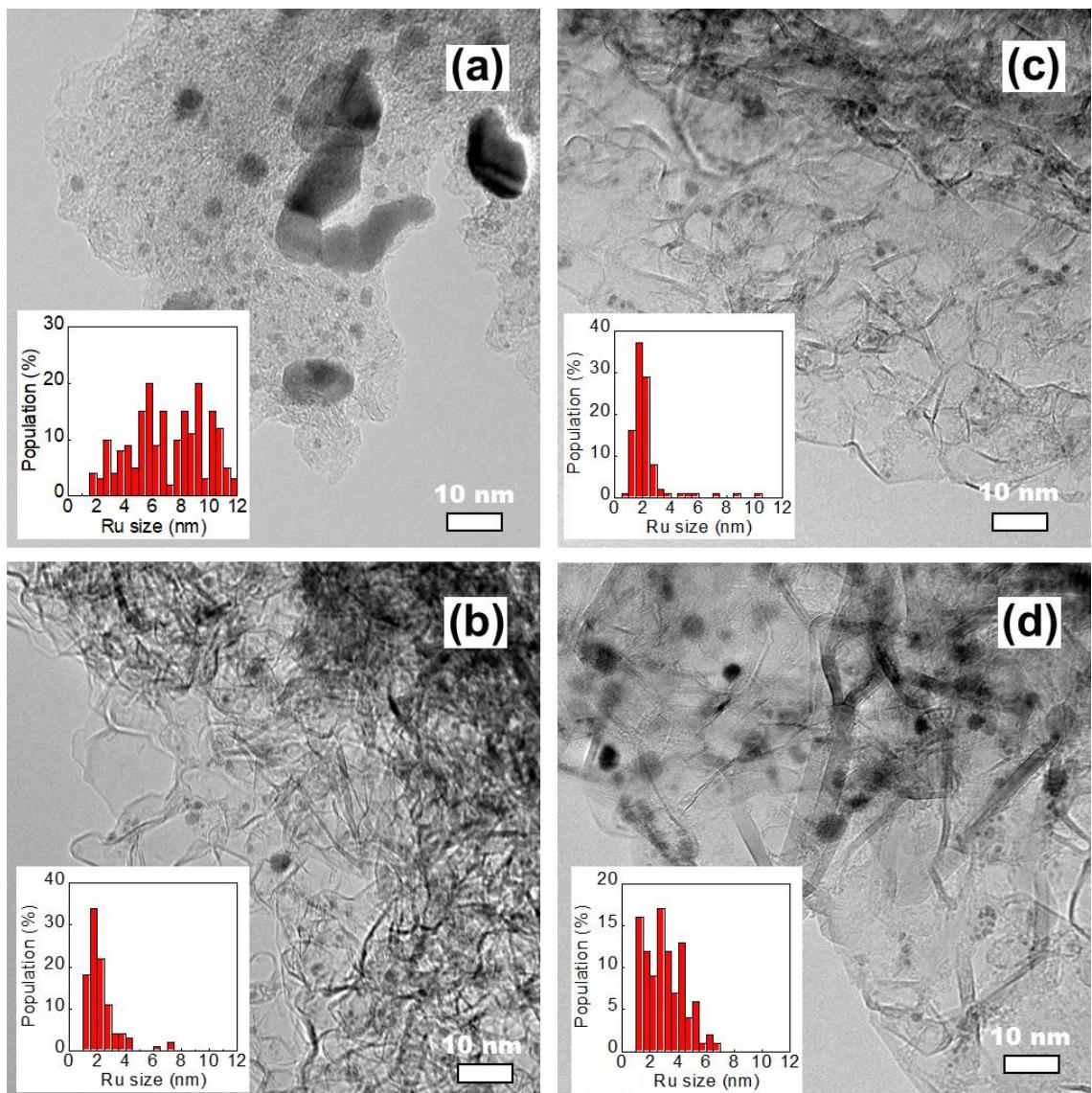


Figure S12. HRTEM images and Ru particle size distributions of the used catalysts. (a) 2.5Cs-10Ru/MPC-AC, (b) 2.5Cs-10Ru/MPC-15, (c) 2.5Cs-10Ru/MPC-18, and (d) 2.5Cs-10Ru/MPC-21.

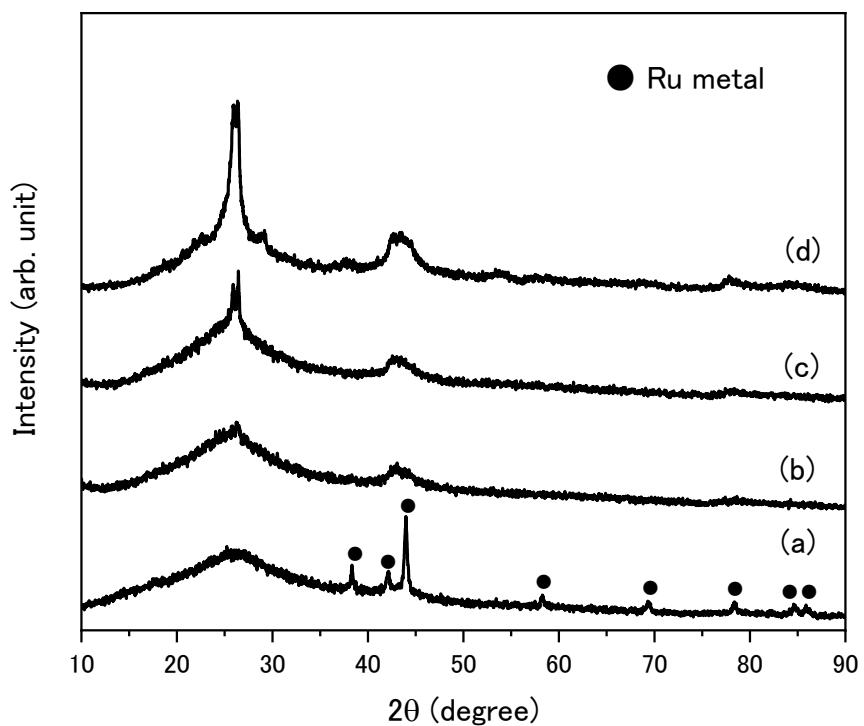


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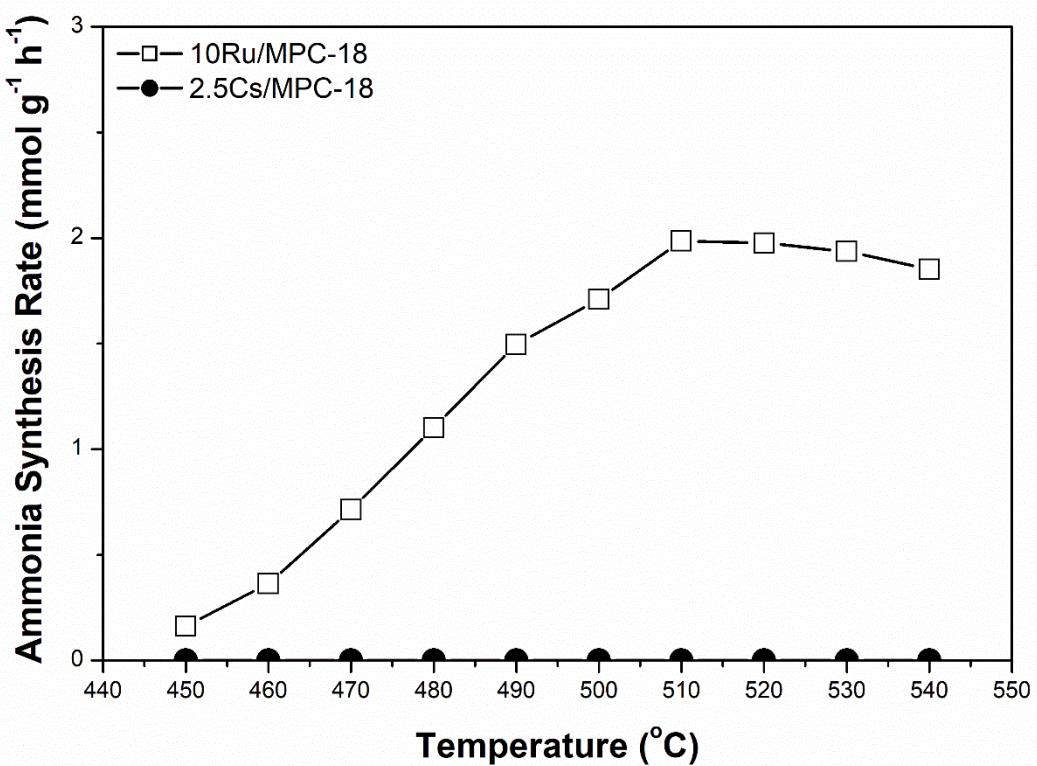


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