Supplementary Information:

One-pot synthesis of N-methylpyrrolidine (NMPD) using Cu- and Ni- modified ZSM-5 as an efficient catalyst

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General procedures for the preparation of 3%Cu-3%Ni/ZSM-5

The 3%Cu-3%Ni/ZSM-5 catalyst was prepared by incipient wetness method using $Cu(NO_3)_2{\cdot}3H_2O$ and $Ni(NO_3)_2{\cdot}6H_2O$ as starting materials. 1.14g $Cu(NO_3)_2{\cdot}3H_2O$ (0.3g Cu) and 1.5g $Ni(NO_3)_2{\cdot}6H_2O$ (0.3g Ni) dissolved in 3mL water, then 10g HZSM-5 was added zeolite with continuous stirring at room temperature. After 2h stirring and 2h aging, the resulted precipitate was dried at 110 ºC for 12h. Then, the precursors were calcined at 500 ºC for 3h in air. The calcined catalysts were denoted as 3%Cu-3%Ni/ZSM-5.

Table S1 The contents of Cu and Ni measured by AAS

catalyst	Content wt%	
	Cu	Ni
1.5%Cu-1.5%Ni/ZSM-5	1.43	1.47
3%Cu-3%Ni/ZSM-5	2.92	2.89
2%Cu-4%Ni/ZSM-5	2.36	3.93
3%Cu/ZSM-5	2.87	
6%Ni/ZSM-5		5.52
3%Cu-3%Ni/ZSM-5*	2.14	2.59

***** after 5 cycles

Table S2 BET analyses of different samples

Sample	Specific surface area (m^2/g)	Pore volume (cm^3/g)	Average pore radius (nm)
HZSM-5	388	0.355	2.459
3%Cu-3%Ni/ZSM-5	285	0.249	2.348
6%Cu-6Ni%/ZSM-5	260	0.205	2.252
3%Cu-3%Ni/ZSM-5[a]	281	0.182	2.163
3%Cu-3%Ni/ZSM-5[b]	299	0.276	2.215

[a] the Si/Al ratio was 50; [b] the Si/Al ratio was 300

Table S3 XPS peak table of 3%Cu-3%Ni/ZSM-5

Name	Start BE	Peak BE	End BE	Atomic %
C1s	2980.8	284.8	279.28	93.33
Cu2p	970.08	932.98	925.28	3.13
Ni2p	890.08	855.8	845.28	3.54

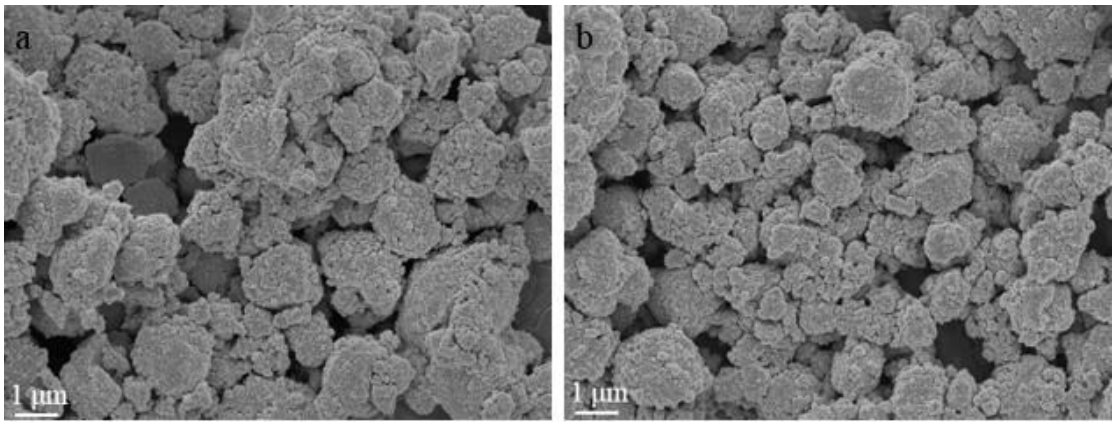

Fig. S1 SEM images of a) H-ZSM-5, b) 3%Cu-3%Ni/ZSM-5

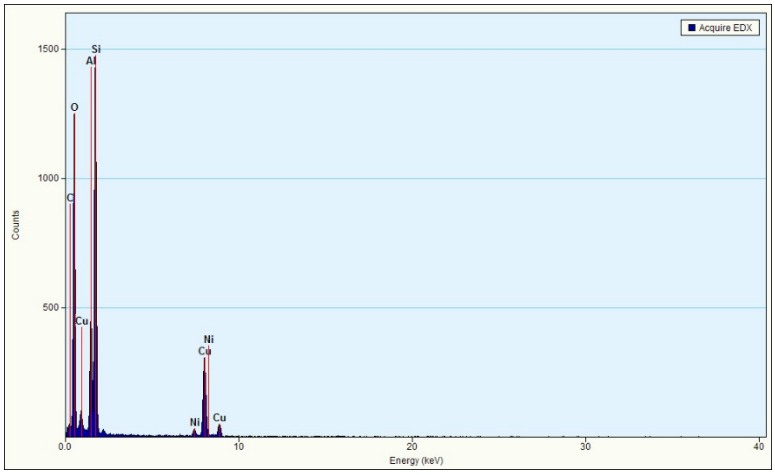

Fig. S2 the EDX pattern of 3%Cu-3%Ni/ZSM-5

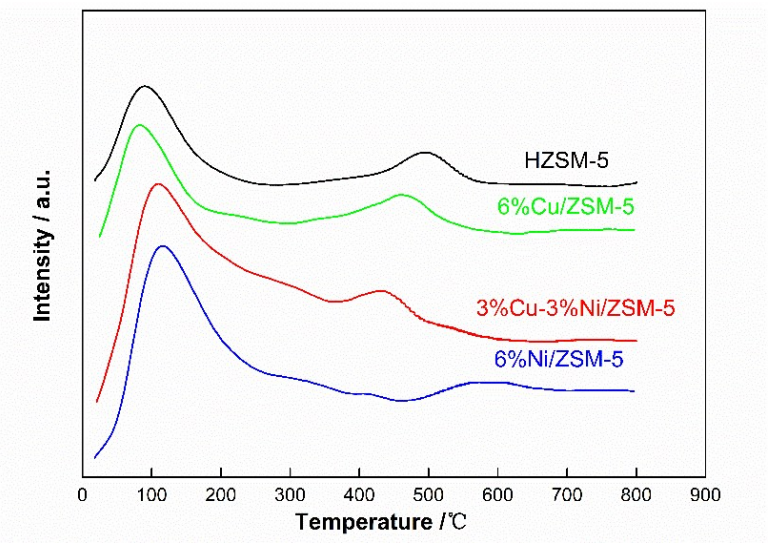

Fig. S3 The TPD curves of different catalysts