Supporting information

Construction of NCMTs@MoO_2/$FeNi_3$ Hierarchical Tubular Heterostructures for Enhanced Performance in Catalysis and Protein adsorption

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Preparation of NCMTs@MoO_2/$FeNi_3$-1

In a typical reaction, 50mg of the as-prepared FeOOH@$NiMoO_4$ were dispersed in 25 mL methanol under ultrasound for 15 minutes. Then another solution containing 23 mg of hexachloro cyclophosphazene and 52 mg of 4, 4'-sulfonyldiphenol in 6 mL of methanol was added drop by drop. After stirring for 5 minutes, 80 μL of triethylamine was added drop wise and the solution was continued to stir for 8 h. The product was collected by centrifugation and washed with water and ethanol for several times before drying at 60 ℃overnight. The obtained product was denoted as FeOOH@$NiMoO_4$@PZS. Then, the as-prepared FeOOH@$NiMoO_4$@PZS powder was placed in a ceramic boat at the middle of a horizontal tube furnace. After heating at 150°C for 1 h and continuously increasing to 500°C and maintaining for 5 h with a ramp rate of 2°C min^{-1} in N_2 gas, the obtained black powder was NCMTs@MoO_2/$FeNi_3$-1.

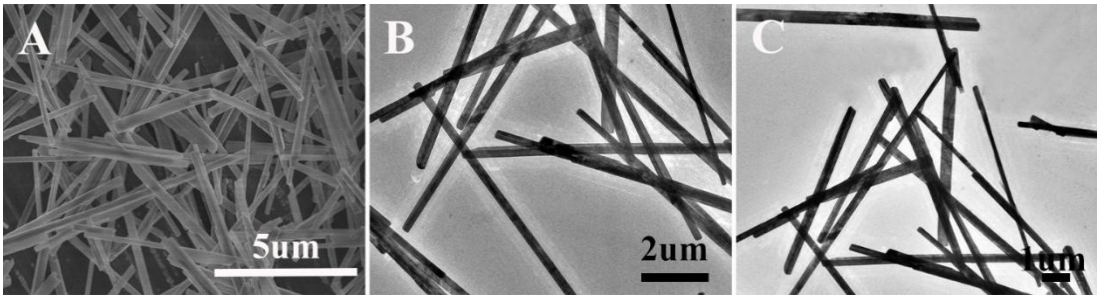

Fig. S1. SEM and TEM images of MoO_3

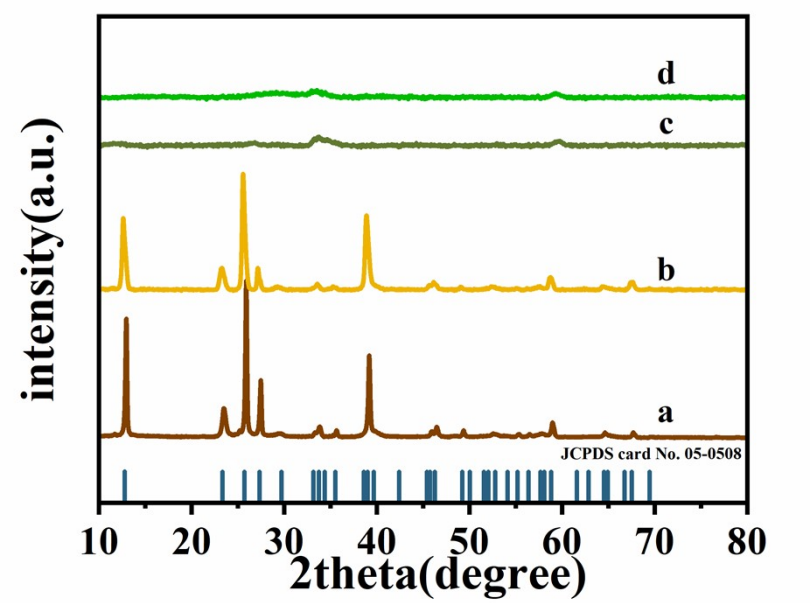

Fig. S2.XRD patterns of MoO_3(a) and MoO_3/FeOOH(b); FeOOH/$NiMoO_4$(c); FeOOH /$NiMoO_4$@PDA(d)

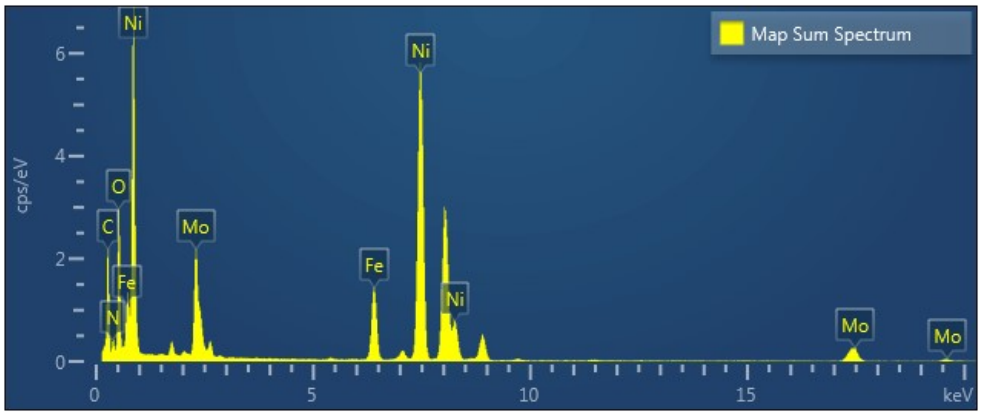

Fig. S3. Energy-dispersive X-rays spectrum of NCMTs@MoO_2/$FeNi_3$.

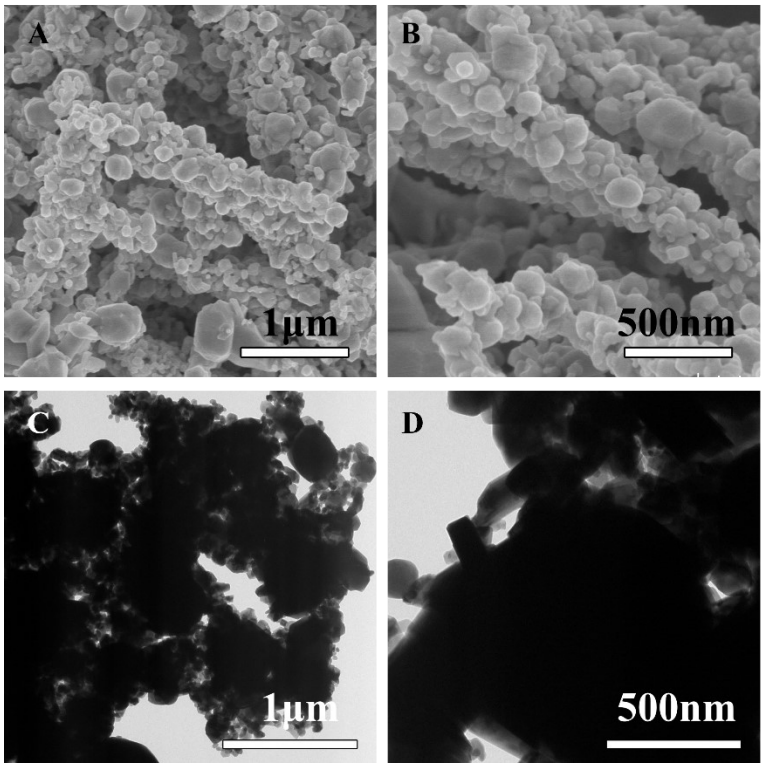

Fig. S4 (A, B) SEM images and (C, D) TEM images of Mo_2C@$Fe_{0.64}Ni_{0.36}$/Ni-900.

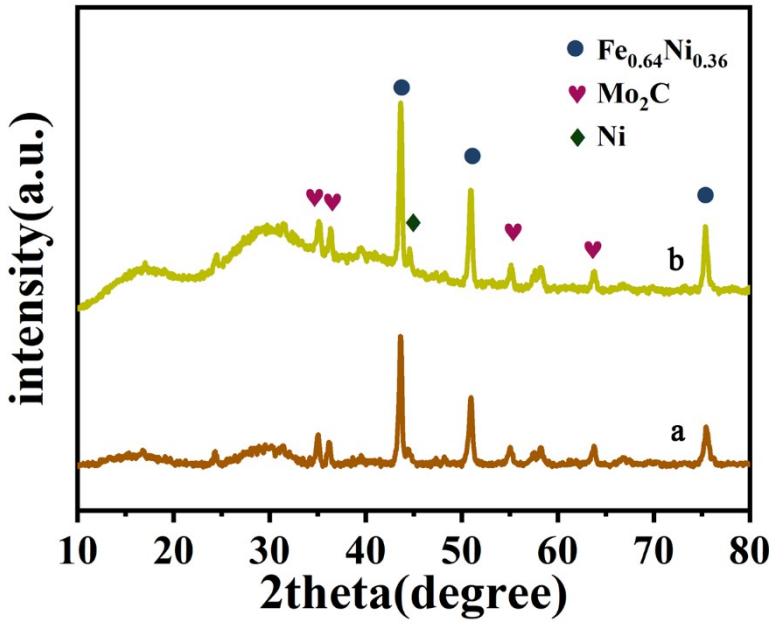

Fig. S5. XRD patterns of (a) $Mo_2C@Fe_{0.64}Ni_{0.36}$/Ni-700 and (b) $Mo_2C@$ $Fe_{0.64}Ni_{0.36}$/Ni-900

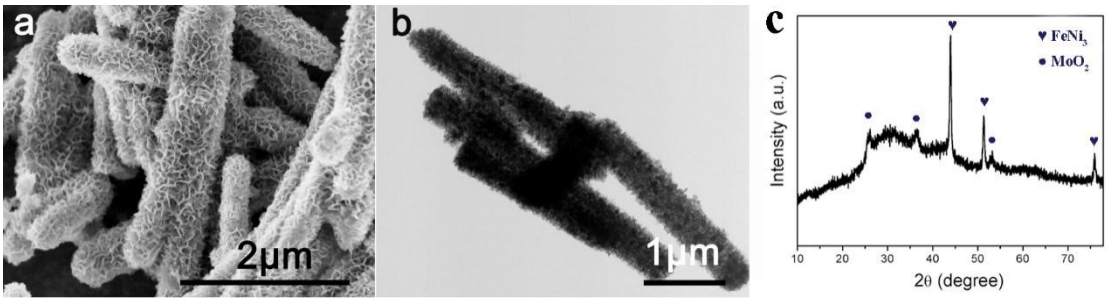

Fig. S6 SEM(a), TEM(b) images and XRD patterns(c) of NCMTs@MoO_2/$FeNi_3$-1

Table S1 ICP data and catalysis activity of NCMTs@MoO_2/$FeNi_3$, $Mo_2C@Fe_{0.64}Ni_{0.36}$/Ni-700 and $Mo_2C@Fe_{0.64}Ni_{0.36}$/Ni-900

Samples	Nickel content (μg/mg)	K ($\times10^{-3}s^{-1}$)	κ ($\times10^{-3}mg^{-1}s^{-1}$)
NCMTs@MoO_2/$FeNi_3$	429.11	17.12	39.90
$Mo_2C@Fe_{0.64}Ni_{0.36}$/Ni-700	215.67	6.94	32.18
$Mo_2C@Fe_{0.64}Ni_{0.36}$/Ni-900	373.97	3.04	8.13

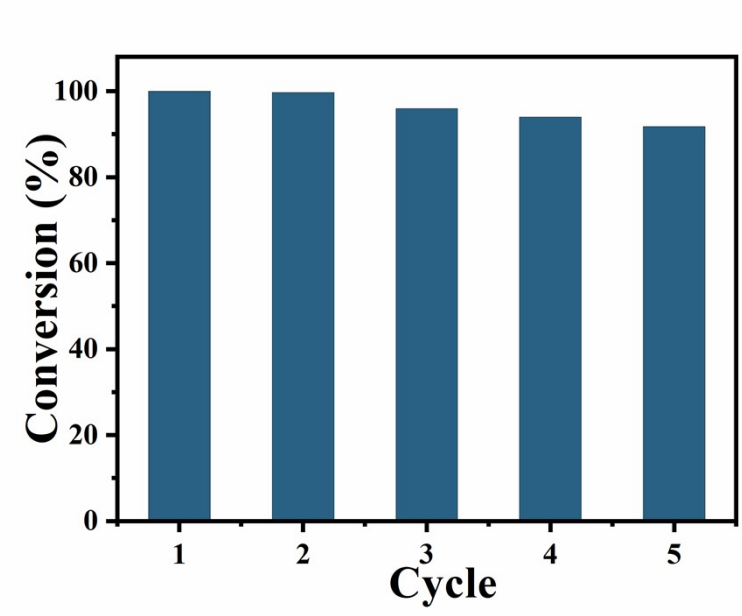

Fig. S7 The recyclability of the NCMTs@MoO_2/$FeNi_3$ as the catalyst for 4-nitrophenol

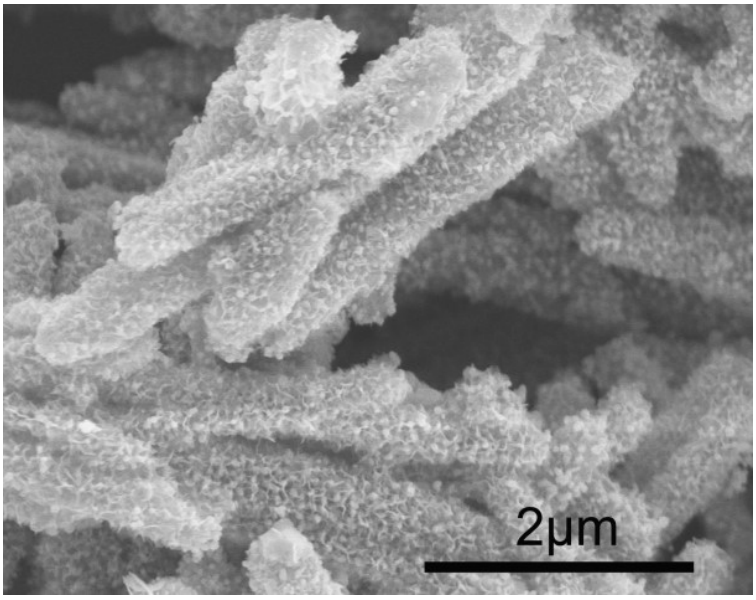

Fig. S8 SEM images of NCMTs@MoO_2/$FeNi_3$ after five catalytic reactions

Table S2. the estimate of Langmuir model and Freundlich model

Langmuir			Freundlich		
Q_m	b	R^2	Q_m	n	R^2
943.40	0.0319	0.9979	58.74	1.87	0.9540