Electronic Supplementary Information for

Sintering resistant Ni nanoparticles exclusively confined within SiO_2 nanotubes for CH_4 dry reforming

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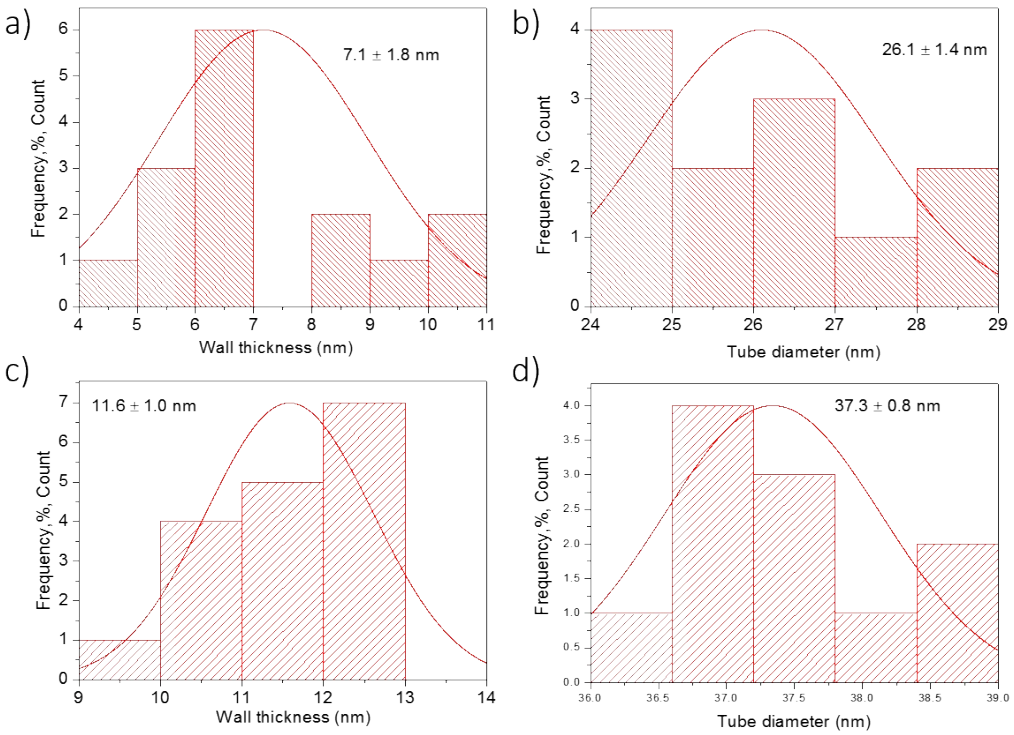

Fig. S1 Wall thickness and tube diameter for NiPhy NTs (a, b) and SiO_2 NTs (c, d).

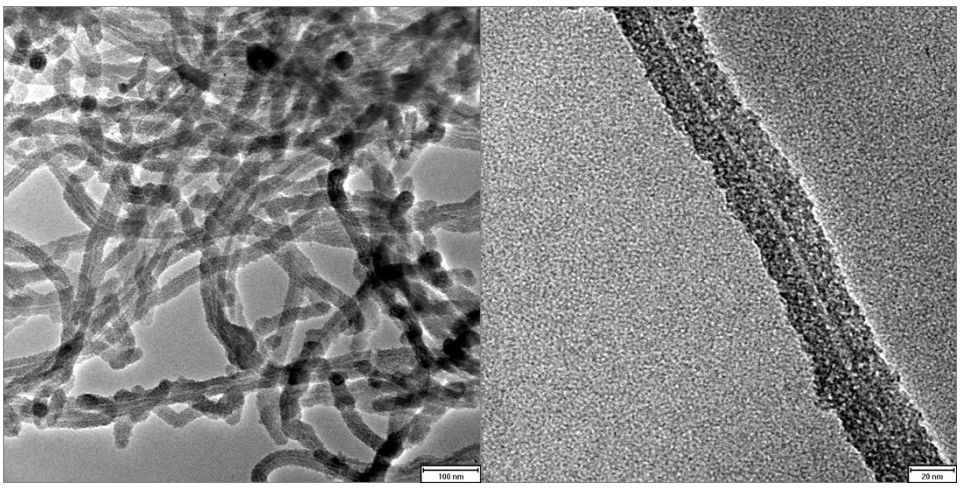

Fig. S2 TEM images of CNT@SiO_2 nanocomposites

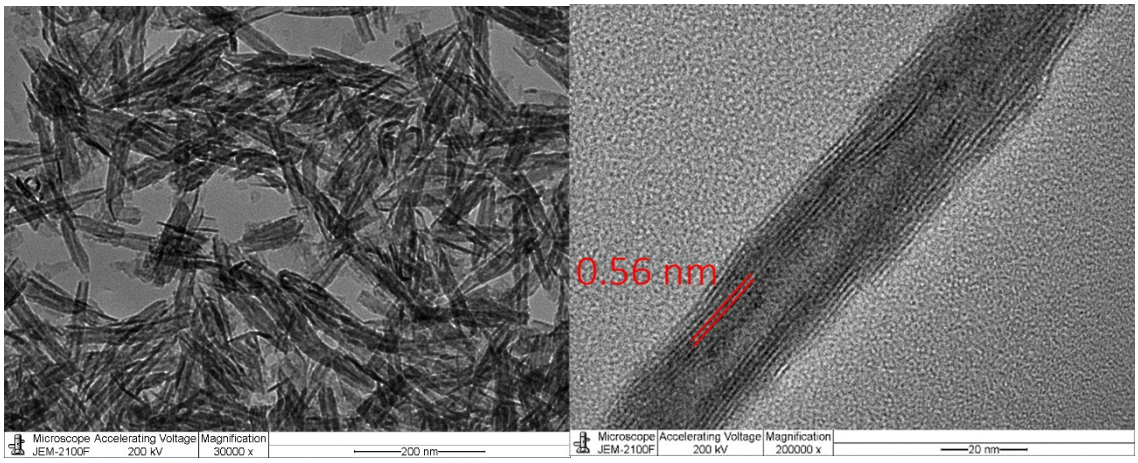

Fig. S3 TEM images of NiPhy NTs after calcination at 700 ^{o}C for 4 h with a ramping rate of 2 ^{o}C/min.

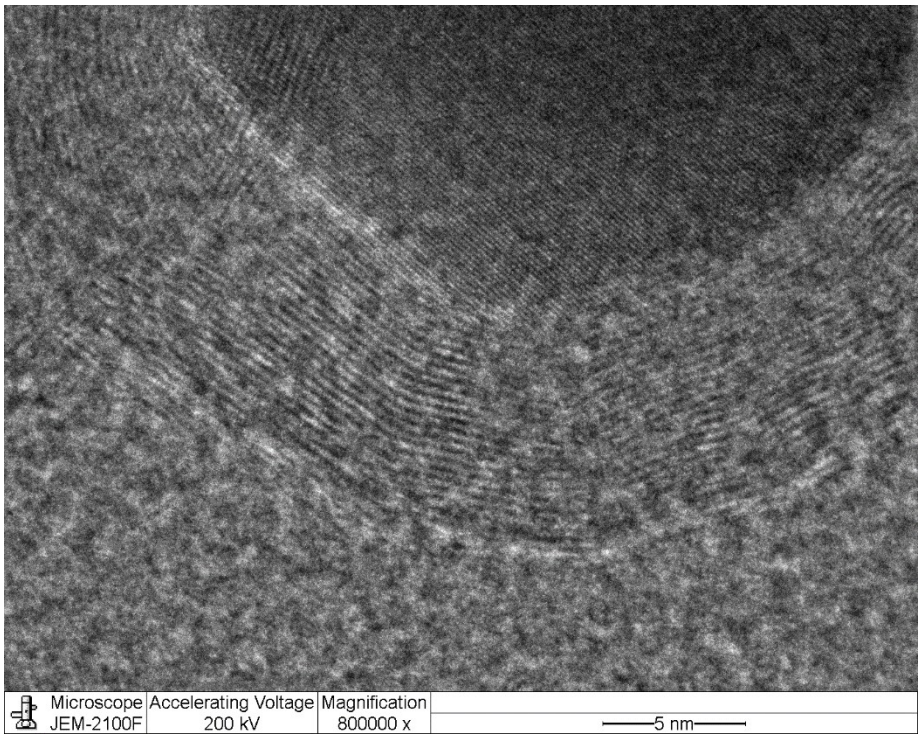

Fig. S4 HRTEM image of Ni/SiO_2 catalysts after 70 h DRM reaction.

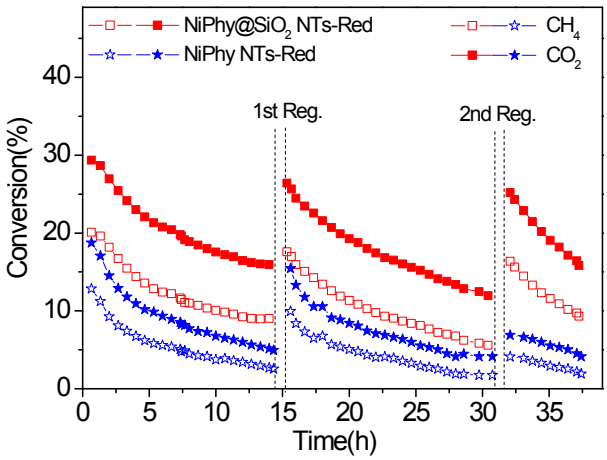

Fig. S5 Regeneration study of catalysts. Reaction conditions: GHSV of 1880 $L \cdot g^{-1}cat \cdot h^{-1}$, 700 °C, 1 atm. 1st and 2nd Reg. stands for the first and second times of catalyst regeneration using synthetic air to remove carbon at 700 °C.

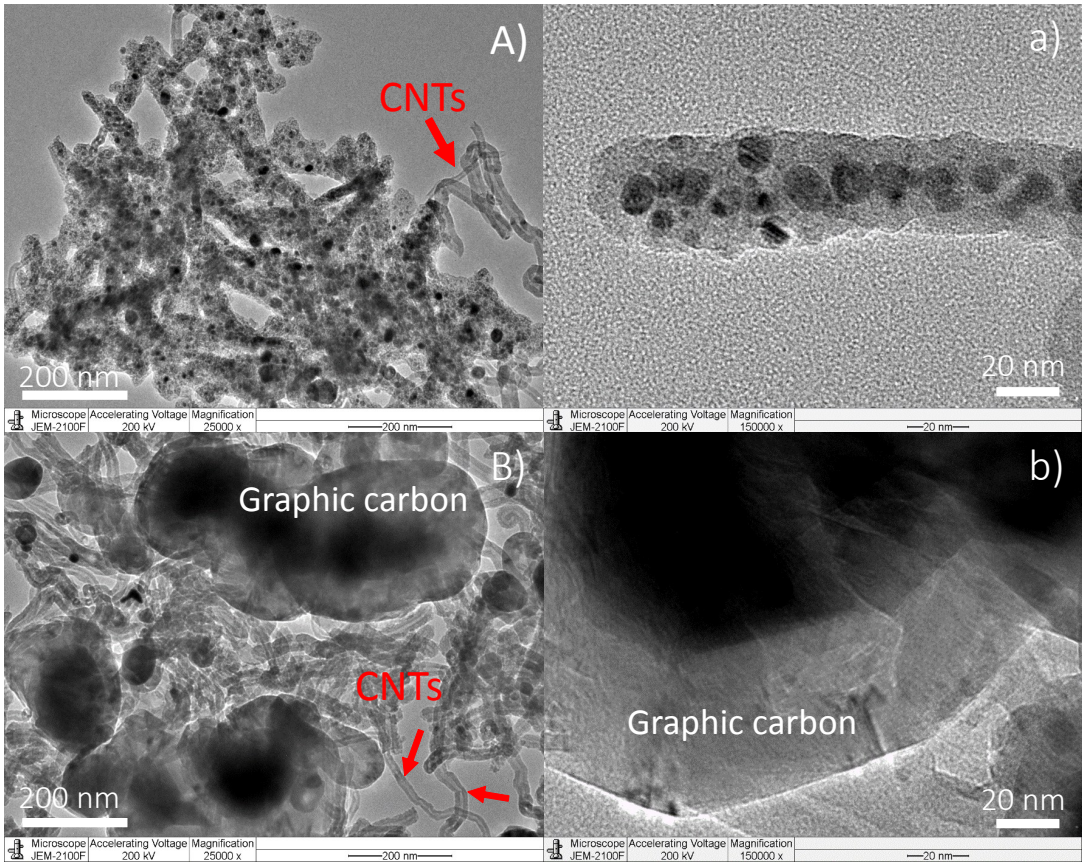

Fig. S6 TEM images of NiPhy@SiO_2 NTs-Red (A and a) and Ni/SiO_2 catalysts (B and b) after regeneration test.

Table S1 Ni 2p XPS peak deconvolution results for catalysts after reduction at 700 °C for 1 h.

NTs	B.E./eV	FWHM/eV	Area
NiPhy	852.6	1.8	4746.200
	854.4	1.8	2235.975
	856.3	1.8	2156.515
$NiPhy@SiO_2$	852.7	1.8	7274.826
	854.5	1.8	1524.929
	856.5	1.8	1211.687
Ni/SiO_2	852.6	1.8	5871.016
	855.1	1.8	2363.345

Table S2 Initial conversions and initial conversions after 1st and 2nd generation.

conversions / catalysts	Initial		1st generation		2nd generation	
	CO_2	CH_4	CO_2	CH_4	CO_2	CH_4
$NiPhy@SiO_2$ NTs-Red	29.2	20.1	26.7	17.4	25.1	16.5
NiPhy NTs-Red	18.7	12.8	15.4	10.1	6.8	4.0