Electronic Supplementary Information

For

Novel microfibrous composite bed reactor: high efficiency H_2 production from NH_3 with potential for portable fuel cell power supplies

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Table S1

Effect of REO loading on the performance of microfibrous entrapped Ni/REO-Al_2O_3 catalyst composite for NH_3 decomposition with a 72sccm feed rate at various reaction temperatures in a 0.5cm^3 bed [a]

REO loading [b] (wt%)	Ni particle size [c] (*d*, nm)	Ni dispersion [d] (*D*, %)	NH_3 conversion at various reaction temperature (mol%)		
			500^{o}C	550 ^{o}C	600 ^{o}C
0	21	4.8	--	--	90.0
5 (CeO_2)	22	4.5	52.2	87.9	99.2
10 (CeO_2)	25	4.0	56.8	90.0	99.99
15 (CeO_2)	25	4.0	57.0	89.7	99.99
10 (La_2O_3)	23	4.3	48.3	84.1	98.2

[a] The Ni loading of 10wt% was constant; the catalytic reaction beds were all reduced at 500^{o}C for 2h in a H_2 flow of 50 sccm prior to NH_3 decomposition. [b] Samples in each step were calcined in air for 2h at 450^{o}C for loading CeO_2 additives but at 250^{o}C for loading Ni. [c] The estimate of Ni particle size (*d*) was approximated by the Scherrer formula on the basis of Ni(111) diffraction line. [d] The nickel dispersion (*D*) was estimated by assuming *d* (nm) =1/*D*.

Table S2

Effect of Ni loading on the performance of microfibrous entrapped Ni/CeO_2-Al_2O_3 catalyst composite for NH_3 decomposition with a 72sccm feed rate at various reaction temperatures in a 0.5cm^3 bed [a]

Ni loading [b] (wt%)	Ni particle size [c] (*d*, nm)	Ni dispersion [d] (*D*, %)	NH_3 conversion at various reaction temperature (mol%)			
			500^{o}C	550 ^{o}C	600 ^{o}C	650 ^{o}C
5	15	6.7	36.0	71.0	95.5	99.3
10	25	4.0	56.8	90.0	99.99	>99.99
15	37	2.7	49.4	84.4	98.3	99.8

[a] The CeO_2 loading of 10wt% was constant; the catalytic reaction beds were all reduced at 500^{o}C for 2h in a H_2 flow of 50sccm prior to NH_3 decomposition. [b] Samples in each step were calcined in air for 2h at 450^{o}C for loading CeO_2 additives but at 250^{o}C for loading Ni. [c] The estimate of Ni particle size (*d*) was approximated by the Scherrer formula on the basis of Ni(111) diffraction line. [d] The nickel dispersion (*D*) was estimated by assuming *d* (nm) =1/*D*.

Table S3

Effect of calcination temperature in the step (1) of loading CeO_2 on the performance of microfibrous entrapped Ni/CeO_2-Al_2O_3 catalyst composite for NH_3 decomposition with a 72sccm feed rate at various reaction temperatures in a $0.5cm^3$ bed [a]

Calcination temp. in step of loading CeO_2 [b] (^oC)	NH_3 conv. at various reaction temp. (mol%)		
	500^oC	550 ^oC	600 ^oC
250	54.7	87.7	99.1
450	56.8	90.0	99.99
550	50.1	75.0	93.9

[a] The constant loading of 10wt% was used for both CeO_2 additive and Ni; the catalytic reaction beds were all reduced at 500^{o}C for 2h in a H_2 flow of 50sccm prior to NH_3 decomposition. [b] In step of loading CeO_2, impregnated samples were calcined in air at appointed temperatures for 2h; after subsequently loading Ni by IWI with $Ni(NO_3)_2 \cdot 6H_2O$, the catalyst samples were calcined in air at a fixed temperature of 250^{o}C for 2h.

Table S4

Effect of calcination temperature in the step (2) of loading Ni on the performance of microfibrous entrapped Ni/CeO_2-Al_2O_3 catalyst composite for NH_3 decomposition with a 72sccm feed rate at various reaction temperatures in a $0.5cm^3$ bed [a]

Calcination temp. in step of loading Ni [b] (^oC)	NH_3 conv. at various reaction temp. (mol%)		
	500^oC	550 ^oC	600 ^oC
250	56.8	90.0	99.99
350	40.6	77.6	96.8
450	37.5	75.4	96.0
550	35.3	70.7	94.4

[a] The constant loading of 10wt% was used for both CeO_2 additive and Ni; the catalytic reaction beds were all reduced at 500^{o}C for 2h in a H_2 flow of 50 sccm prior to NH_3 decomposition. [b] In step of loading CeO_2, impregnated samples were calcined in air at a fixed temperature of 450^{o}C for 2h; after subsequently loading Ni by IWI with $Ni(NO_3)_2 \cdot 6H_2O$, the catalyst samples were calcined in air at appointed temperatures for 2h.

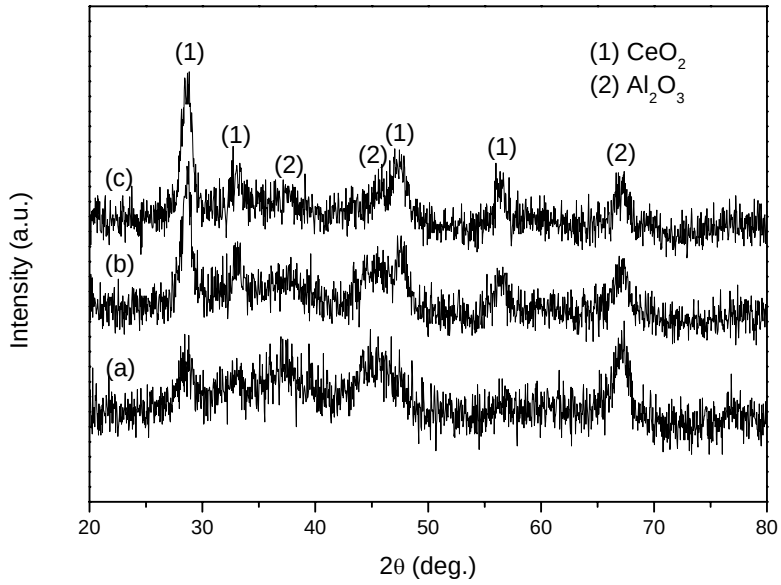

Fig. S1 XRD patterns of CeO_2-Al_2O_3 support samples with CeO_2 loading of (a) 5wt%, (b) 10wt%, and (c) 15wt%. CeO_2-Al_2O_3 support particulates were the same samples as in Table **S1** that just were loaded with CeO_2 but not with Ni, and were collected by disclosing the microfibrous network for XRD experiment.

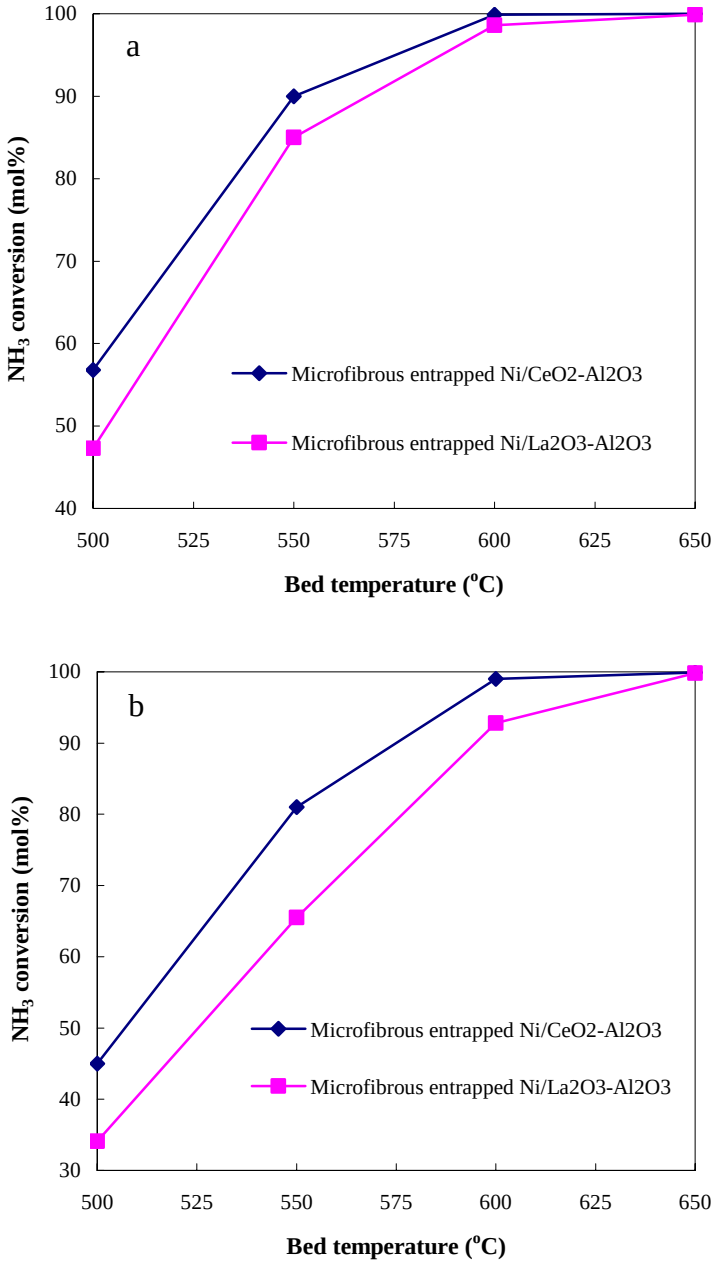

Fig. S2 NH_3 conversion over CeO_2- and La_2O_3-promoted microfibrous entrapped Ni/Al_2O_3 catalyst composites at various bed temperatures in bed volume of 0.5ml with NH_3 feed rate of (a) 72sccm and (b) 145sccm, respectively.

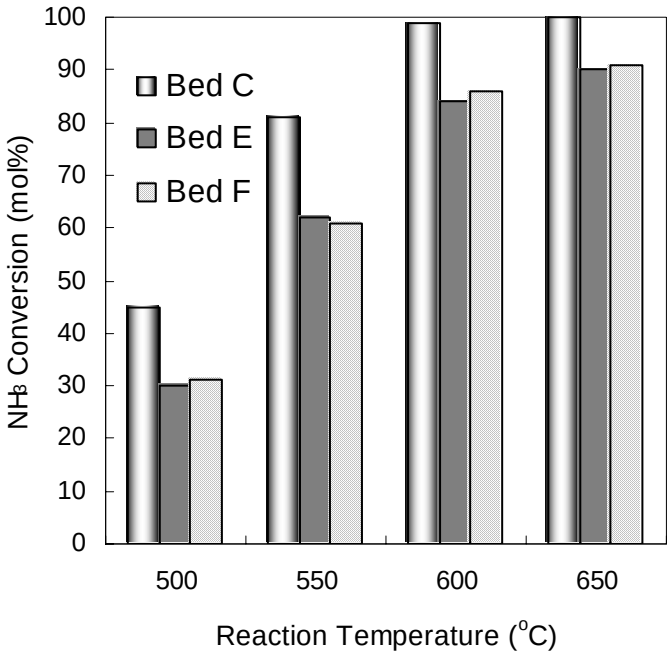

Fig. S3 Comparison of the reactivity of bed C with beds E and F at various reaction temperatures with a 145sccm NH_3 feed gas rate. See *footnotes* in Table 2 of the paper for the descriptions of beds C, E and F.

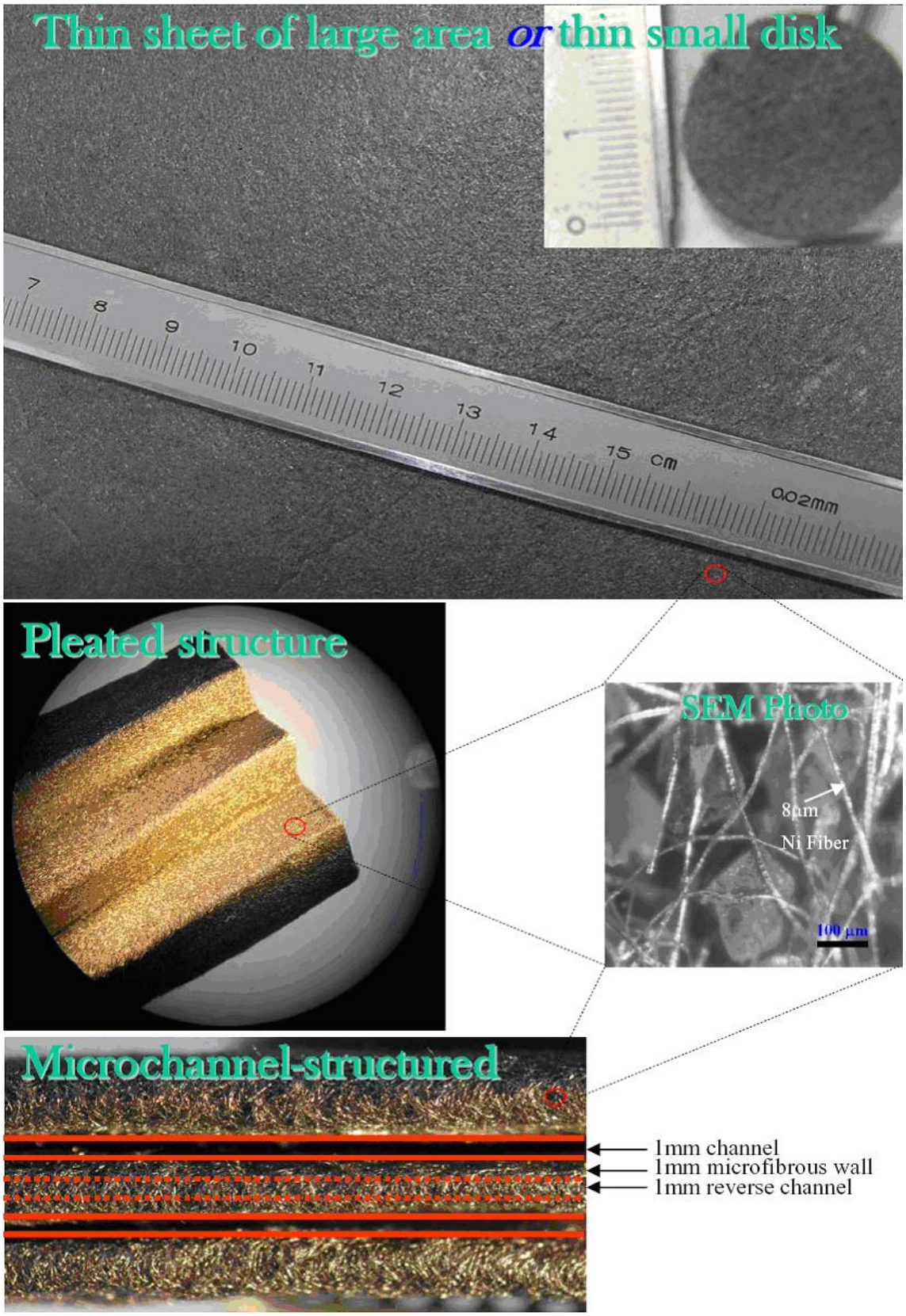

Fig. S4 Unique form factors of microfibrous media with micron-sized particulates using 8μm diameter nickel microfibers.

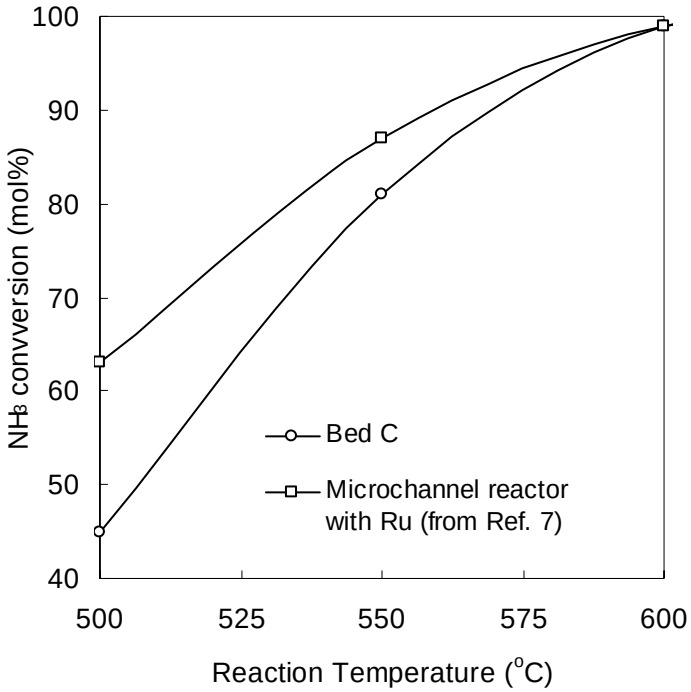

Fig. S5 Comparison of the performance of bed C with the state-of-the-art microchannel reactor with Ru for NH_3 decomposition at various reaction temperatures with a 145 sccm NH_3 feed gas rate. See *footnotes* in Table 2 of the paper for the descriptions of bed C.

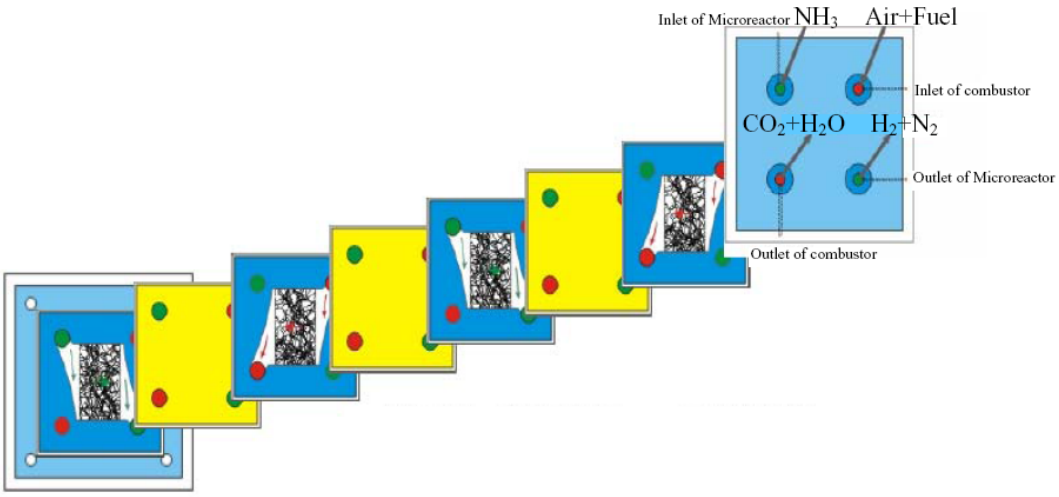

Fig. S6 Proposed model for a small plate-type reactor system with integrated microcombustor design based on our microfibrous catalyst composite for NH_3 decomposition to produce *CO-free* H_2.