Supporting Information

Development of novel Au/CaO nanoribbons from bifunctional building block for biodiesel production

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Fig. S1 SEM images of as-prepared $Ca(MAA)_2$ nanoribbons in the ethanol/water mixture with a volume ratio of 5:1 (a) and 100:1 (b).



Fig. S2 (a) shows the ¹H NMR spectra and detailed peak assignments of Ca(MAA)₂ nanoribbons. The signals appearing at 1.76, 5.24 and 5.56 ppm, with an integral ration close to 3:1:1, can be assigned to the methyl (H^a) and two types of methylene (H^b and H^c) protons of the methacrylate ion (MAA⁻). Then the characteristic asymmetric and symmetric stretching vibrations peaks of carboxylate groups, appearing at around 1546 and 1420 cm⁻¹ respectively in the FTIR spectra (Fig. S2 (b)) of the Ca(MAA)₂ nanoribbons, confirm the successful coordination of MAA⁻ and Ca²⁺.



Fig. S3 TGA curve of Ca(MAA)₂ nanoribbons.

TGA curve (obtained under O₂ atmosphere, heating rate: 1 $^{\circ}$ C min⁻¹) of Ca(MAA)₂ nanoribbons further confirms the formula of Ca(MAA)₂. The weight loss of 1.77 % before 70 $^{\circ}$ C is assigned to the loss of crystal water. The weight loss of 52.10 % in the range of 160 to 416 $^{\circ}$ C corresponds to the loss of the organic components, Ca(MAA)₂ turns to CaCO₃ (calc. 52.42 %). While the complete decomposition temperature is about 610 $^{\circ}$ C, CaO is obtained finally since the weight loss from 160 to 610 $^{\circ}$ C is about 72.96 %, which is almost in agreement with the calculated value of 73.31%.



Fig. S4 SEM image of the Ca(MAA)₂ nanoribbons.



Fig. S5 XRD patterns of the Ca(MAA)₂ nanoribbons (black) and singlecrystal of Ca(MAA)₂ (red).



Fig. S6 SEM images of the Ca(MAA)₂ nanoribbons prepared by using methanol (a), isopropanol (b), DMF (c) , THF (d), n-butanol (e) and DMSO (f) as the initiation solvents respectively.

Solvent	α	β	3	Solubility in water (20 °C)	Whether forming Ca(MAA) ₂ nanoribbons?	
water	1.17	0.47	78	Complete	No	
methanol	0.93	0.66	33	Complete	Yes	
ethanol	0.83	0.75	25	Complete	Yes	
n-butanol	0.79	0.80	18	7.7%	Yes	
isopropanol	0.76	0.84	20	Complete	Yes	
dimethylfor mamide (DMF)	0.00	0.76	37	Complete	Yes	
Dimethyl sulfoxide (DMSO)	Dimethyl sulfoxide (DMSO) 0.00		47	Complete	Yes	
tetrahydrof uran (THF)	0.00	0.55	8	Complete	Yes	

Table S1. The Kamlet-Taft parameters (α : hydrogen-bond donor ability, β : hydrogen-bond acceptor ability) and dielectric constant (ϵ) of the solvents used in this study.



Fig. S7 FTIR spectra of (a) Ca(MAA)₂ nanoribbons and (b) Ca(MAA)₂/Au(III) nanoribbons. The peak around 480 cm⁻¹ corresponds to the Au(II)-alkene stretching frequency, and is highlighted by the dotted line.

Table	S2 .	Experimental	data	from	а	variety	of	research	papers	on	FAME	of	transterification
reaction catalyzed by CaO-based catalyst.													

	Transterification								
CaO catalyst specification	Feedstock	Catalyst (wt.%)	M/O	Temp.(°C	FAME	Ref.			
Mixed CaO-La ₂ O ₃	Soybean oil	5	20	58	94.3% (1 h)	1			
$CaO@ (Sr_2Fe_2O_5-Fe_2O_3)$	Soybean oil	0.5	12	70	94.9% (2 h)	2			
Nano-magnetic catalyst KF/CaO–Fe ₃ O ₄	Stillingia oil	4	12	65	95.0% (3 h)	3			
Ag/bauxite nanocomposite	Sunflower oil	0.3	9	67	94.0% (3 h)	4			
K ₂ CO ₃ (7%)/nano CaO	Canola oil	3	9	65	97.7% (8 h)	5			
Magnetic nanoparticle MgFe ₂ O ₄ @CaO	Soybean oil	1	12	70	98.3% (3 h)	6			
CaO-based/Au nanoparticles	Sunflower oil	3	9	65	90-97% (3 h)	7			
Nano-sized CaO from hydrate source	Palm olein	7	15	65	95.7% (45 min)	8			
Commercially available CaO	Soybean oil	1	12	65	54.67% (2 h)	This work			
Porous CaO nanocatalyst	Soybean oil	1	12	65	91.3% (2 h)	This work			
CaO nanoribbons	Soybean oil	1	12	65	98.67% (2 h)	This work			
Au/ CaO nanoribbons	Soybean oil	1	12	65	96.04% (2 h)	This work			



Fig. S8 GC-MS chromatogram of the final FAME product.



Fig. S9 SEM images of commercially available CaO and porous CaO (obtained through thermal process by calcination of CaO nanoribbons in air at 700 $^{\circ}$ C for 10 min, heating rate: 10 $^{\circ}$ C min⁻¹).



Fig. S10 Nitrogen adsorption–desorption isotherms and pore size distributions of Au/CaO nanoribbons (a and b), porous CaO (c and d) and bulk CaO (e and f), respectively.



Fig. S11 CO₂-TPD curves of the Au/CaO nanoribbon, porous CaO and bulk CaO.

Basicity of three kinds of CaO materials were determined using temperature programmed desorption of CO₂, and the results are shown in Fig. S11. Obviously, three kinds of broad desorption peaks were observed from 650 °C to 785 °C of Au/CaO nanoribbon, porous CaO and bulk CaO, respectively. On account of the basic strength distribution on Au/CaO nanoribbon, porous CaO and bulk CaO and bulk CaO were maximized at 750 °C, 710°C and 690 °C, respectively, Au/CaO nanoribbon possessed remarkably higher basic strength compared to porous CaO and bulk CaO. This result might be attributed to the higher active basic-sites generated by the special 1D nanoribbon-like structure. In addition, Au/CaO nanoribbon and porous CaO showed higher basic density compared to bulk CaO due to their higher CO₂ adsorption capacity.



Fig. S12 Water contact angles of (a) CaO nanoribbons (the average is 58.6°) and (b) Au/CaO nanoribbons (the average is 35.8°).



Fig. S13 FTIR spectra of (a) Au/CaO nanoribbons, (b) Au/CaO nanoribbons after soaked in glycerol, (c) CaO nanoribbons and (d) CaO nanoribbons after soaked in glycerol. The peak around 3638 cm⁻¹ corresponds to the O–H stretching frequency of Ca(OH)₂, and is highlighted by the dotted line.

To further demonstrate the effect of Au NPs on the improvement of surface hydrophobicity of CaO nanoribbons, FTIR spectra were tested. The as-prepared CaO and Au/CaO nanoribbons were exposed to the air in order to react with water vapour to partially form Ca(OH)₂, appearing at around 3638 cm⁻¹ in the FTIR spectra (Fig. S13 a and c) (the peak around 1438 cm⁻¹, 871 cm⁻¹ and 713 cm⁻¹ corresponds to the symmetric stretching, in-plane and out-plane flexural vibrations of CaCO₃ formed due to the combination of CO₂ in the air). Then the above samples were soaked in glycerol at 65 °C under stirring with a constant speed for 2 h, followed by centrifugation and washed with absolute ethanol. Comparing Fig. S13 (a) and (b), (c) and (d) we find the peak of Ca(OH)₂ disappears after CaO nanoribbons were soaked in glycerol, while there is almost no change in the FTIR spectra of Au/CaO nanoribbons. The comparison results show that Au NPs can really protect CaO nanoribbons against attachment of hydrotropic substance, reducing CaO leaching in the cyclic catalytic systems.



Fig. S14 XRD patterns of recovered (a) Au/CaO and (b) CaO nanoribbons catalysts after reused for seven times.



Fig. S15 SEM images of recovered (a) Au/CaO and (b) CaO nanoribbons catalysts after reused for seven times.

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