Electronic Supplementary Material (ESI) for Catalysis Science & Technology
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Electronic Supplementary Information (ESI)

Transesterifications Using Hydrocalumite Synthesized from Waste Slag: An Economical and Ecological Route for Biofuel Production

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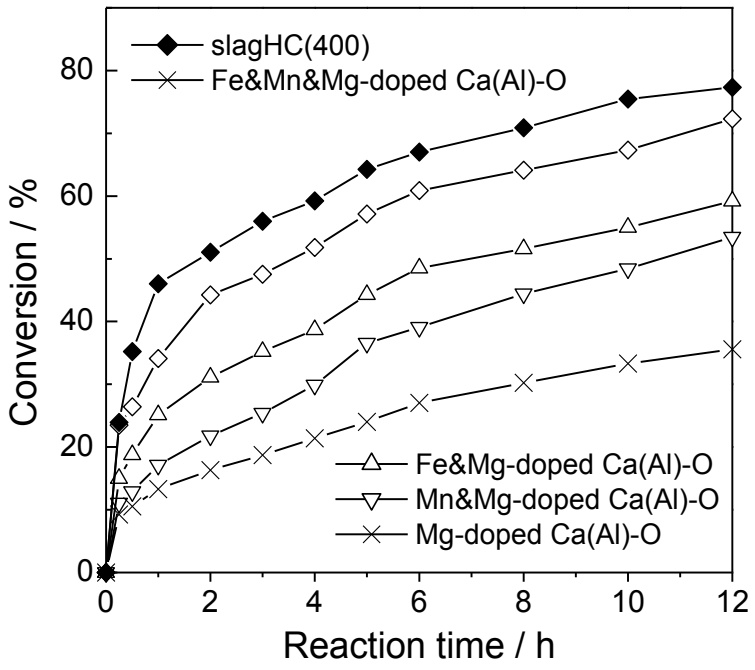

Fig. S1 Comparison of reaction kinetics in transesterification between *n*-ethyl butyrate and methanol using slagHC(400) and Ca(Al)–O mixed oxide containing different impurity elements. The doping amount of each element was adjusted to be the same as those contained in slagHC(400) (Mg: 10.6, Fe: 1.0 and Mn: 0.4 mol% as a metalic element, respectively). There was no significant difference in structures and morphologies by the doping.

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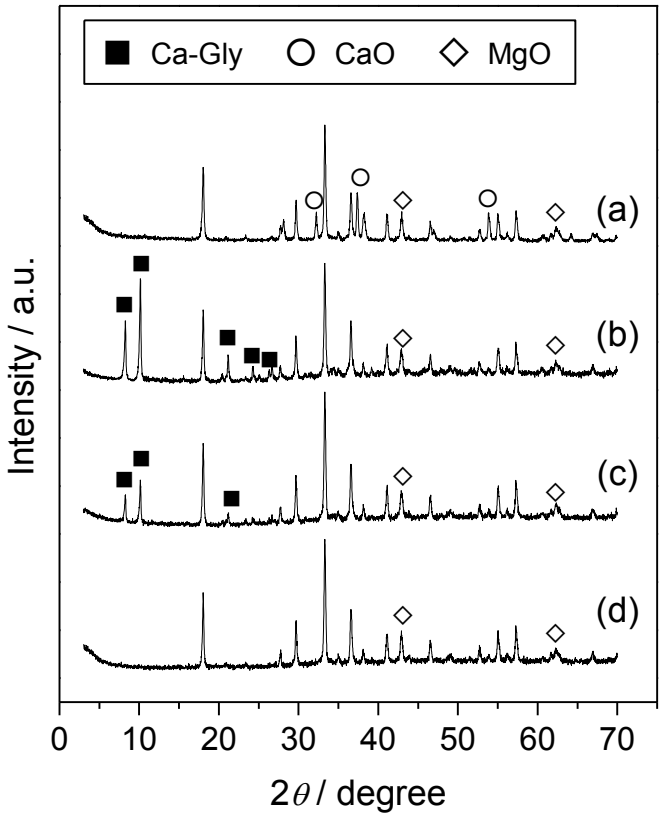

Fig. S2 XRD patterns of (a) fresh slagHC(800) catalyst and recovered slagHC(800) catalysts after (b) 1st run, (c) 2nd run and (d) 3rd run. For each recycling test, the spent catalyst was recovered after each catalytic run by filtration, washing and drying under vacuum to avoid contact with the atmosphere, and was repeatedly used under the same reaction conditions described in the experimental section without further activation.

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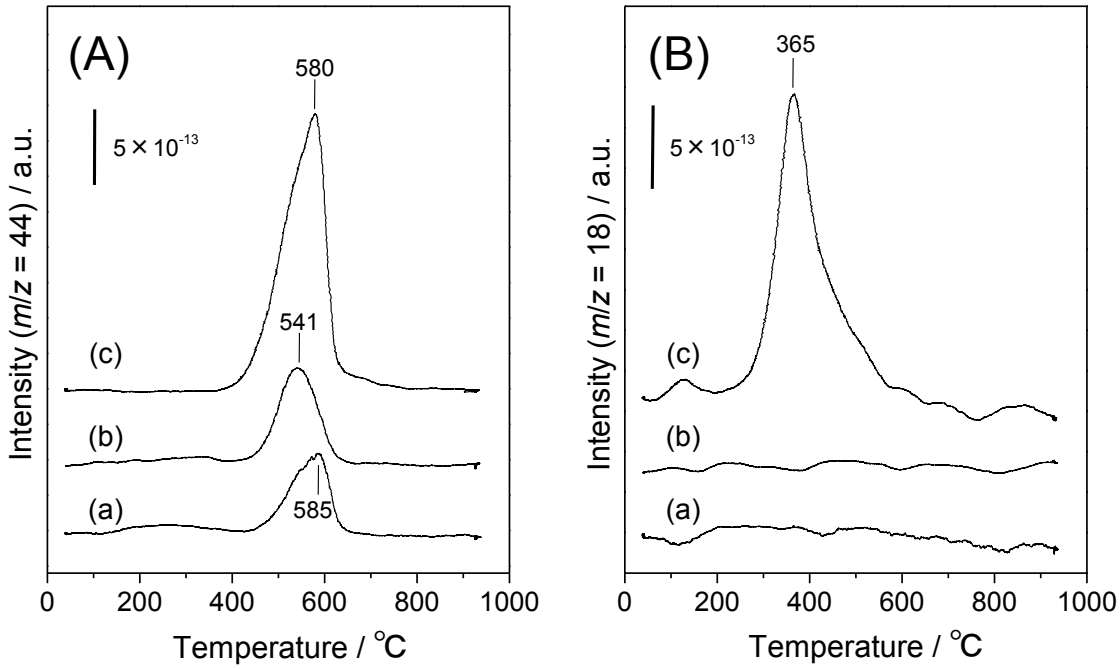

Fig. S3 Temperature programmed desorption profiles of (A) CO_2 (m/z = 44) and (B) H_2O (m/z = 18); (a) slagHC, (b) Ca–Al–Cl hydrocalumite and (c) CaO. Prior to TPD analyses, the samples were pretreated under the same conditions as those before the transesterification reaction of soybean oil (salgHC and Ca–Al–Cl hydrocalumite were pretreated at 800 °C in air for 6 h, and CaO was pretreated at 900 °C in air for 6 h). A desorption band centered at around 540–580 °C in CO_2-TPD is attributable to chemisorbed CO_2 species. The amounts of CO_2 adsorbed during the pretreatment process were estimated to be 0.40, 0.51 and 1.67 mmol/g for slagHC(800), Ca–Al–Cl(800) and CaO, respectively. A desorption band centered at 365 °C in H_2O-TPD is attributable to the dehydration of OH groups associated with $Ca(OH)_2$ species.

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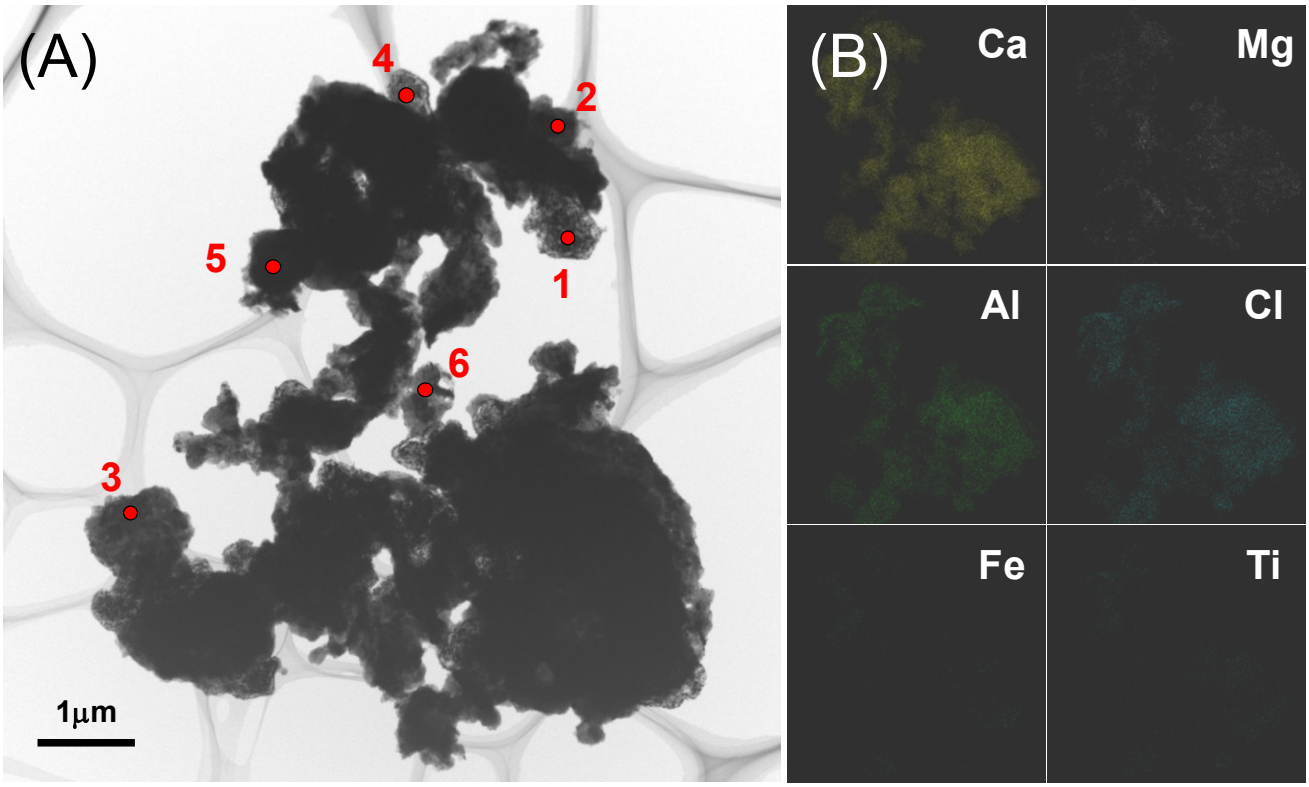

Fig. S4 (A) Fieldemission transmission electron microscopy (FE-TEM) images of slagHC(800) obtained with a Hitachi Hf-2000 FE-TEM instrument equipped with a Kevex energy-dispersive X-ray detector operated at 200 kV. (B) Elemental mappings (image for Mn is not shown).

Table S1 Chemical compositions of selected points of slagHC(800). The number of the points corresponds to those shown in Fig. S4 (A).

Point	Chemical component (mol%) [a]							Molar ratio	Main phase
	Ca	Mg	Al	Cl	Fe	Ti	Mn	Ca/Al	
1	46.3	2.1	37.7	12.4	1.0	0.3	0.2	1.23	mayenite
2	59.5	9.9	20.5	9.2	0.6	0.2	0.1	2.90	CaO
3	43.7	11.4	36.0	7.8	0.7	0.3	0.1	1.21	mayenite
4	62.1	11.0	15.0	11.0	0.6	0.2	0.1	4.14	CaO
5	7.5	88.9	2.0	0.5	0.8	0.2	0.1	3.75	MgO
6	40.5	2.3	46.1	9.9	0.8	0.3	0.1	0.88	mayenite

[a] Determined by EDX.