

Supporting information

The cooperative effect of Lewis and Brønsted acid sites on Sn-MCM-41 catalysts for the conversion of 1,3-dihydroxyacetone to ethyl lactate

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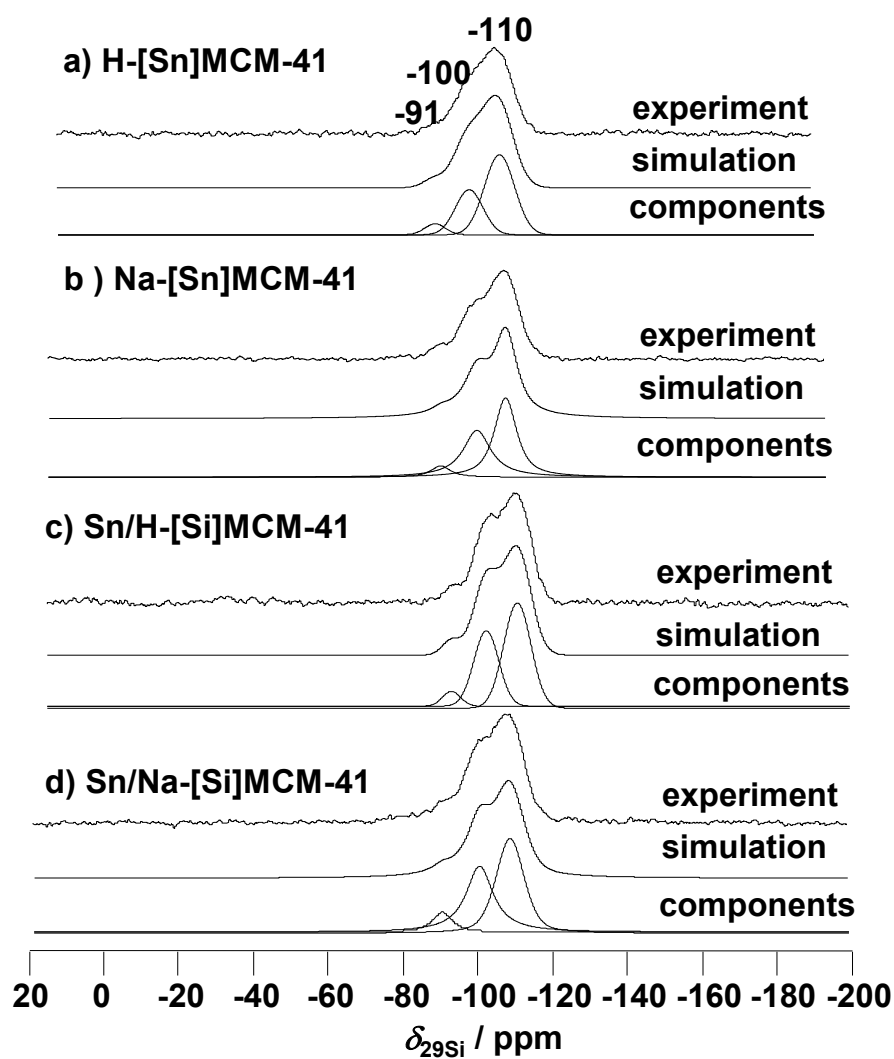


Figure S1. ^{29}Si MAS NMR spectra of a) H-[Sn]MCM-41, b) Na-[Sn]MCM-41, c) Sn/H-[Si]MCM-41, and d) Sn/Na-[Si]MCM-41

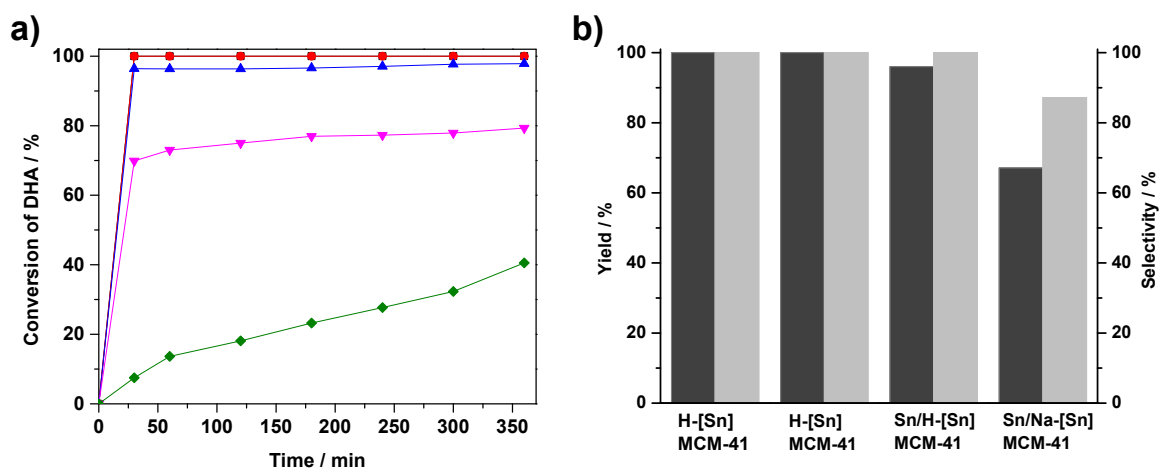


Figure S2. (a) DHA conversion as a function of reaction time over various Sn-containing MCM-41 materials (H-[Sn]MCM-41 (black), Na-[Sn]MCM-41 (red), Sn/H-[Si]MCM-41 (blue), Sn/Na-[Si]MCM-41 (pink)) and H-ZSM-5 (green), and (b) yield (black) and selectivity (grey) to ethyl lactate. Reaction conditions: 0.05g of MCM-41 catalyst, 5 mL ethanol solution containing 0.4 M DHA, at 90 °C after 6 h reaction time under stirring.

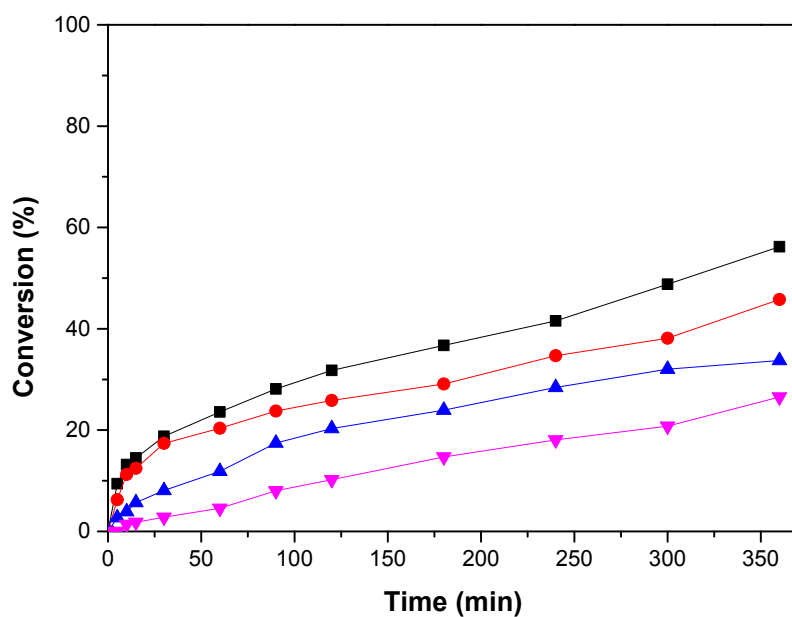


Figure S3. DHA conversion as a function of reaction time over various Sn-containing MCM-41 materials (H-[Sn]MCM-41 (black), Na-[Sn]MCM-41 (red), Sn/H-[Si]MCM-41 (blue), and Sn/Na-[Si]MCM-41 (pink)). Reaction conditions: 0.05g of MCM-41 catalyst, 5 mL ethanol solution containing 0.4 M DHA, at 45 °C after 6 h reaction time under stirring.

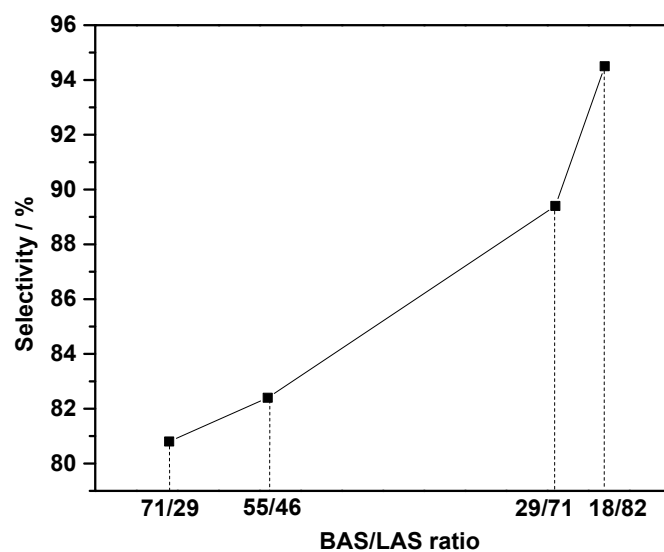


Figure S4. The effect of the BAS/LAS ratio on the selectivity to ethyl lactate at 27-28% conversion of DHA. Reaction conditions: 0.05g of MCM-41 catalyst, 5 mL ethanol solution containing 0.4 M DHA, at 45 °C after 6 h reaction time under stirring.

Table S1. ICP analysis results of Sn-containing MCM-41 catalysts.

	Sn (mg/kg)	Si (mg/kg)	Na (mg/kg)	Na/Si
Sn-H[Si]MCM-41	64.3	539	22.6	0.05
Sn-Na[Si]MCM-41	67.7	428	67.70	0.19
H[Sn]MCM-41	41.7	431	6.14	0.02
Na[Sn]MCM-41	17.4	149	6.87	0.06

Table S2. Selective reaction of DHA over Sn-containing MCM-41 materials at about 30 % conversion at 45 °C.

Catalyst	DHA conversion	Selectivity		
		Ethyl lactate	Pyruvaldehyde diacetal (PADA)	Pyruvaldehyde (PA)
H-[Sn]MCM-41	28	80.8	15.8	3.2
Na-[Sn]MCM-41	27	84.4	12.5	3.1
Sn/H-[Si]MCM-41	28	89.4	7.6	2.9
Sn/Na-[Si]MCM-41	27	94.5	4.8	0.7

Reaction conditions: 0.05g of MCM-41 catalyst, a 5 mL ethanol solution containing 0.4 M DHA.