Selective Hydrogenation of Lauric Acid into Alcohols over Bimetallic Ru-Sn catalysts

Rodiansono[1]*, Maria Dewi Astuti[1], Abdullah[1], Agung Nugroho[2], Susi[2]
[1] *Department of Chemistry, Lambung Mangkurat University, Jl. A. Yani Km 36 Banjarbaru, Indonesia 70714.*
[2]*Department of Agro-Industrial Technologi, Lambung Mangkurat University, Jl. A. Yani Km 36 Banjarbaru, Indonesia 70714*
Corresponding author: rodiansono@unlam.ac.id (R. Rodiansono); *Telp./fax: +62-511-477 3112*

1. Introduction

Fatty alcohols have been explored for potential use in medicine, health suplements and biofuels. Recently, Ru-Sn/Al_2O_3 and Pt/TiO_2 showed higher activity for hydrogenation carboxylic acid into fatty alcohols.[1,2] Here, we evaluated the catalytic performances of supported bimetallic Ru-Sn instead of Ni-Sn alloy catalysts. We synthesised supported Ru-Sn catalyst with Ru/Sn mol ratio of 3.0 using the similar procedure to our previous report.[3]

2. Experimental

Typical procedure of synthesis of Ru-Sn/TiO_2 (loading amount of 5%wt and molar ratio Ru to Sn is 3.0) as follow: 0.1803 g (0.869 mmol) $RuCl_3$ was dissolved in H_2O and 0.0661 g (0.293 mmol $SnCl_2{\cdot}2H_2O$ was dissolved in ethanol, mixed together at room temperature dan 10 mL of ethylene glycol was also added droply under gentle strirring. The mixture then transferred into autoclave teflon reactor for hydrothermal processing at 423 K for 24 h. The obtained black powder was reduced with H_2 gas at 400°C for 1.5 h prior to characterization (XRD, TEM, NH_3-TPD, and N_2-adsorption) and catalytic reaction.[3] The synthesised Ru-Sn/TiO_2 catalysts were applied for the selective hydrogenation lauric acid (LA; $C_{12}H_{24}O_2$) in stainless-batch reactor with glass tube fitted-inside at 120-180°C, ethanol/H_2O solvent, 2-8 MPa H_2 for 2-16 h. Reactant and products were analyzed by GC and GC-MS using an internal standard technique.

3. Results and Discussion

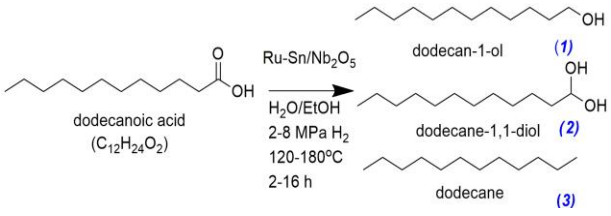

Table 1. Results of catalysts screening for lauric acid hydrogenation

Entry	Catalyst	Conv.[a] (%)	Selectivity[a](%)			
			(1)	*(2)*	*(3)*	*Others*[b]
1	Ni-Sn(1.5)/AlOH	89	90	1	4	5
2	Ni-Sn(1.5)/TiO_2	>99	98	2	0	0
3	Ru-Sn(3.0)/TiO_2	>99	99	1	0	0
4	Ru-Sn(3.0)/Nb_2O_5	>99	90	2	6	2
5[c]	Ru-Sn(3.0)/Nb_2O_5	>99	80	0	10	10

***Reaction conditions*:** catalyst, 5.0 mg, lauric acid, 2.0 mg, EtOH 3 mL, 150°C, H_2 3 MPa, 6 h. [a]Reactant and products were analyzed by GC and GC-MS. Conversion and selectivity were calculated by using an internal standard technique. [b]Unknown products. [c]Reaction temperature at 180°C for 6 h.

Results of selective hydrogenation of lauric acid (LA) over supported bimetallic Ni-Sn and Ru-Sn catalysts are summarized in Table 1. Over Ni-Sn(1.5)/AlOH catalysts, 89% LA was converted to 90% selectivity of dodecane-1-ol (entry 1). The completed conversion of LA was achieved with 98% selectivity of dodecane-1-ol when Ni-Sn(1.5)/TiO_2 was employed as catalyst (entry 2).

Interestingly, with >99% LA conversion over Ru-Sn(3.0)/TiO_2 and Ru-Sn(3.0)/Nb_2O_5 catalysts, the selectivity of dodecane-1-ol was 99% and 90%, respectively (entries 3 and 4). Over Ru-Sn(3.0)/Nb_2O_5 catalyst, the formation of dodecane was observed with 10% selectivity when the temperature reaction was increased to 180°C under the same reaction time (entry 5). Further investigation on the role of solvent, time profile, reaction temperature are also discussed systematically.

1) Toba, M., et al. *Appl. Catal. A.* **189**, 243–250 (1999)
2) Manyar, H.G., et al. *Chem. Commun.* **46**, 6279-6281 (2010)
3) Rodiansono, et al. *Chem. Lett*. **41**, 769−771 (2012)

Keywords: selective hydrogenation, lauric acid, dodecane-1-ol, dodecane, bimetallic Ru-Sn catalysts