SULFATED ZIRCONIA SUPPORTED ON SBA-15 FOR SELECTIVE ESTERIFICATION OF GLYCEROL WITH FATTY ACIDS TO MONOGLYCERIDE

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Nomenclature

FAME	Fatty acid methyl ester
HRTEM	High-resolution transmission electron microscopy
IR	Infrared
MCM-41	Mobile Composition of Matter No. 41
NH_3-TPD	Temperature-programmed desorption of ammonia
SBA-15	Santa Barbara Amorphous No. 15
SZ	Sulfated zirconia
SZSBA-15	Sulfated zirconia supported on SBA-15
TEM	Transmission electron microscopy
VIH	Vapour-induced hydrolysis
XPS	X-ray photoelectron spectroscopy

INTRODUCTION

In recent years, the development of environmentally friendly super-acidic catalysts has been conducted to replace the conventional homogeneous catalysts commonly used in the current petrochemical industry. Besides its high acidity compared to that of concentrated H_2SO_4, superacid catalysts have other advantages, including high stability at higher temperatures, resistance to deactivation, and easy to regenerate [1]. Moreover, these catalysts could provide new opportunities for developing environmentally clean processes. Generally, these superacid catalysts have been prepared by following three simple steps, which are (1) preparation of metal oxide gels using metal salts, (2) impregnation with sulphating agents (H_2SO_4 or $(NH_4)_2SO_4$) and (3) calcination at high temperature [2].

Recently, various sulphated oxide catalysts, including sulphated zirconia [3]-[4], sulphated tin oxide [5], and sulphated titania [6], have been investigated for various reactions. Among them, sulphated zirconia (SZ) has received considerable interest owing to its high thermostability and super-acidic properties. Furthermore, this catalyst also exhibited high catalytic in various catalytic reactions, including alkylation, hydrocarbon isomerisation, and cracking reactions [7]. Among the sulphated oxide catalyst investigated, SZ exhibited high acidity as shown by Hammett acidity function (H_o), which was -16.1. Meanwhile, the H_o value for sulphated titania was measured to be -14.6, slightly lower than that of sulphated zirconia. Although the acidity of sulphated tin oxide is the highest, as shown in Table 7.1, the difficulty of obtaining the oxide gels from the metal salt limits its application [2].

Table 7.1 Acidic strength of solid super-acids calcined at various temperatures [8]

Catalyst	Acid strength (H_o value)
SO_4/SnO_2 (550°C)	−18.0
SO_4/ZrO_2 (650°C)	−16.1
SO_4/HfO_2 (700°C)	−16.0
SO_4/TiO_2 (525°C)	−14.6
SO_4/Al_2O_3 (650°C)	−14.6
SO_4/Fe_2O_3 (500°C)	−13.0