Available online at www.sciencedirect.com

ScienceDirect

journal homepage: www.elsevier.com/locate/he

Highly dispersed Ru on K-doped meso–macroporous SiO_2 for the preferential oxidation of CO in H_2-rich gases

*T. Niu, L.H. Zhang, Y. Liu**

Collaborative Innovation Center of Chemical Science and Engineering (Tianjin), Tianjin Key Laboratory of Applied Catalysis Science and Engineering, School of Chemical Engineering, Tianjin University, Tianjin 300072, China

ARTICLE INFO

Article history:
Received 2 November 2013
Received in revised form
18 March 2014
Accepted 20 March 2014
Available online 18 April 2014

Keywords:
Nanoparticle
Ruthenium
Silica
Preferential oxidation
Hydrogen

ABSTRACT

In this work, highly dispersed Ru nanoparticles which had a uniform small nanoparticle size were supported on K-promoted meso–macroporous SiO_2 by using the simple impregnation method. The effect of the size of Ru nanoparticle on the catalytic performance for the preferential oxidation of CO (CO-PROX) in H_2-rich gases was investigated. Meanwhile, the related mechanism on size effect was discussed. The catalysts were characterized by using techniques of transmission electron microscopy, temperature-programmed reduction and CO-chemisorption. The results indicate that the K-promoted Ru/SiO_2 catalyst with the size of metal Ru particles at about 7 nm showed obviously higher turnover frequency (TOF) than that of $K\text{-}Ru/SiO_2$ with smaller size of Ru particles of around 2 nm. As for oxidizing CO to CO_2 on specific weight of ruthenium, the catalyst with the smaller size of metal Ru exhibited better performance owing to its much higher specific surface area of metal Ru. The catalyst with the smaller size of Ru nanoparticles showed much better methanation formation resistance for CO and CO_2. The K-promoted and highly dispersed Ru on SiO_2 exhibited excellent activity and selectivity for the CO-PROX reaction.

Copyright © 2014, Hydrogen Energy Publications, LLC. Published by Elsevier Ltd. All rights reserved.

Introduction

The fuel of hydrogen for fuel cells is generally produced by using steam reforming of hydrocarbons and water gas shift reactions, which contains around 1 vol.% of CO [1]. However, trace amount of CO leads to the poisoning of the platinum anode of fuel cells [2]. Thus, the carbon monoxide is required to be removed to less than 10 ppm or 100 ppm for the CO-resistant anodes. The preferential oxidation (PROX) of CO has been supposed to be the most promising method [3].

The reported catalysts for CO-PROX mainly include noble metal catalysts, such as Ru [4], Rh [5], and Pt [6], base metal oxide catalysts, such as $CuO–CeO_2$ [7] and $CoOx\text{-}CeO_2$ [8], and gold catalysts [9]. Among them, the nano Ru catalyst is one of the most potential candidates [10]. Ru catalyst supported on mesoporous silica displays a high activity and selectivity for CO-PROX. For example, Wang et al. [11] studied the catalysts of Ru supported on different mesoporous SiO_2, including MCM-41, MCM-48, SBA-15 and KIT-6 for the CO-PROX, and pointed out that the catalytic performance of the catalysts

* *Corresponding author*. Tel.: +86 022 87401675.
E-mail address: yuanliu@tju.edu.cn (Y. Liu).
http://dx.doi.org/10.1016/j.ijhydene.2014.03.155
0360-3199/Copyright © 2014, Hydrogen Energy Publications, LLC. Published by Elsevier Ltd. All rights reserved.

highly related to the dispersion of ruthenium, the porosity of the support, the reducibility of ruthenium species and the interaction between Ru and the support. Among catalysts studied, Ru/MCM-41 presented the highest catalytic activity. Previous studies in our lab have found that K-promoted Ru/meso–macroporous SiO_2 exhibited excellent activity for CO-PROX [12].

The effect of metal nanoparticle size on catalytic activity has aroused considerable interests in terms of academic and practical viewpoints. Chen et al. [13] reported that the

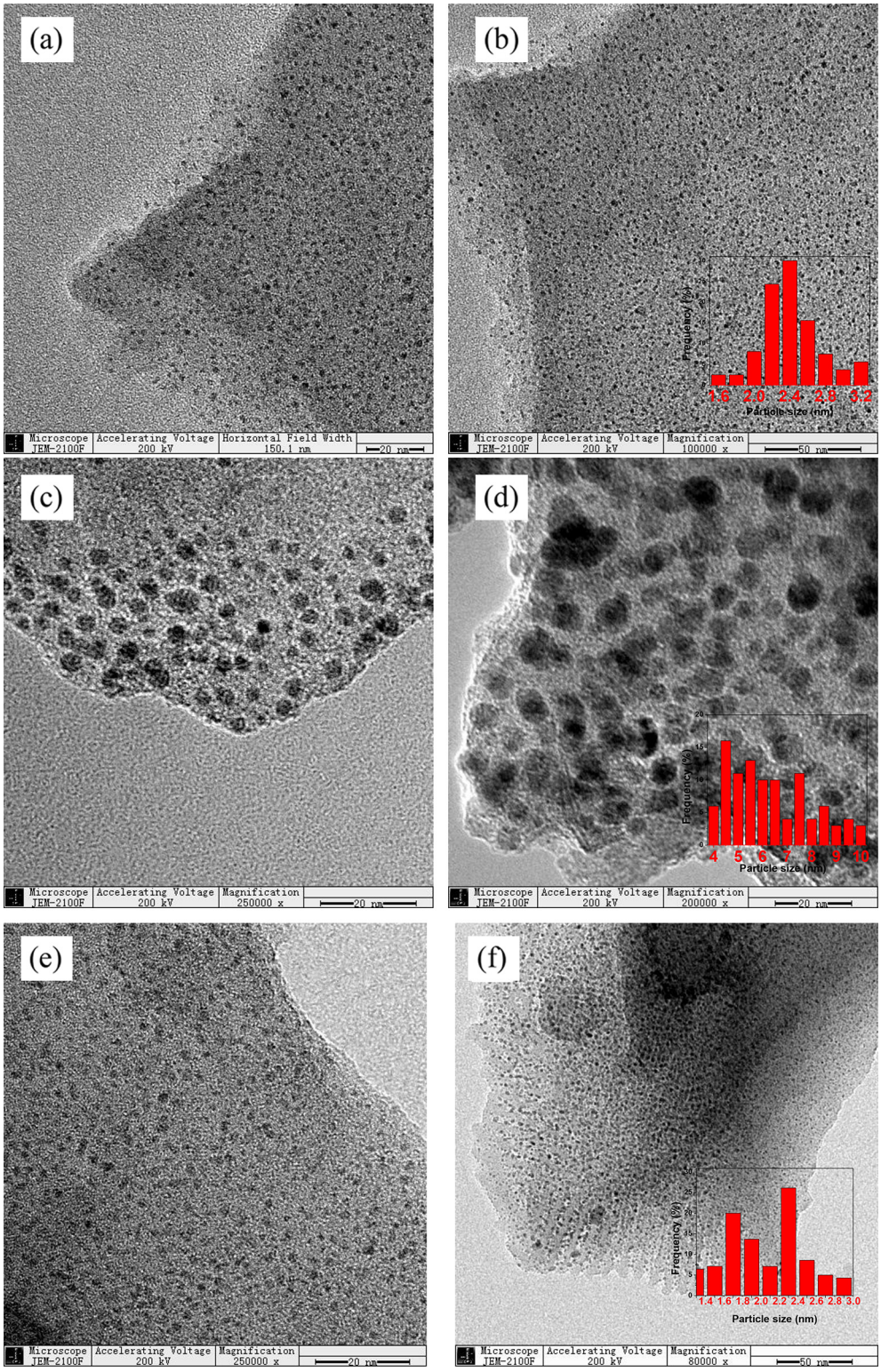

Fig. 1 – TEM images of (a, b) Ru/SiO_2(SI); (c, d) K-Ru/SiO_2(COI); (e, f) K-Ru/SiO_2(SEI); (g, h) K-Ru/SiO_2(SC), and a corresponding Ru particle size distributions; Scale bar: 20 nm for (a, c, d, e, g), 50 nm for (b, f, h).

Download English Version:

https://daneshyari.com/en/article/1272686

Download Persian Version:

https://daneshyari.com/article/1272686

Daneshyari.com