

Hydrolysis of cellulose to glucose over Ru/Carbon catalysts

Yang-Chuang Chang (張揚狀)^{a*}, Yu-Wen Chen^b

^a Green Technology Research Institute, CPC Corporation, Taiwan

^b Department of Chemical Engineering, National Central University, Jhong-Li 32001 Taiwan

*Corresponding author E-mail: 078701@cpc.com.tw

Hydrolysis of cellulose to glucose is one of the most important subjects in green chemistry. Fukuoka and his coworkers have done many pioneer works in this field. Ru/CMK-3 has been reported to be a good catalyst for this reaction. However, synthesis of CMK-3 is tedious. In addition, cellulose is a bulky material to diffuse into the pores of CMK-3 even it is a large pore material. It is believed that cellulose-catalyst is a solid-solid reaction and diffusion is not an important role because cellulose is difficult to diffuse into pores. How to have close contact between cellulose and catalyst is the prerequisite for this reaction. In this study, various commercial activated carbons were obtained from various vendors. Carbon was treated with H₂SO₄ to create more function groups on the surface. The functional group is not only the active site for hydrolysis of cellulose, but also the adsorption site for Ru. It can help to disperse Ru on carbon. Ru/carbon was prepared by conventional incipient-wetness impregnation method. The catalysts were reduced in hydrogen flow at 400 °C. Cellulose and catalysts were milled using ZrO₂ balls. Different grinding times of cellulose and catalyst were tested. Reaction was carried out in an autoclave at 230 °C with various amounts of water and catalyst. The product was analyzed by an HPLC. The results show that solid-solid reaction is a key role in this reaction, therefore longer grinding time of cellulose and catalyst can help the contact between these two materials and result in high conversion. It is important to quench the reactor or glucose would further hydrolyze to alcohols. Sulfonation of carbon can create more functional groups on the surface of carbon and improve the conversion of cellulose. Carbon obtained from Merck is the best support among all carbon materials. The optimum cellulose/water ratio is 10. Too much water would suppress the reaction. The optimum Ru loading is 3 wt%. By regulating the metal loading, grinding time, and reaction condition, one can obtain the conversion of 82% and glucose yield of 74%.