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Oxidative-Acidic Bifunctional Catalyst of Niobium-Phosphate-Titania Supported on Silica in Production of Diols

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Niobium-phosphate-titania supported on silica as oxidative-acidic bifunctional catalyst has been synthesized via sol-gel and impregnation methods in different sequences namely, (i) TiO_2, Nb_2O_5 and PO_4^{3-} impregnated stepwise onto silica (P/Nb/Ti/Si), (ii) mixture of TiO_2 and Nb_2O_5 impregnated onto silica, followed by impregnation of PO_4^{3-} (P/(Nb+Ti)/Si), and (iii) Nb_2O_5 and PO_4^{3-} impregnated onto TiO_2-SiO_2 (P/Nb/Ti-Si). The results indicated the different properties resulted from varied interactions among SiO_2 support, TiO_2 catalyst and its modifiers have greatly affected the bifunctional catalytic behavior of the synthesized materials. The XRD results showed an identified peak of titanium oxide in sample P/Nb/Ti/Si. Meanwhile, samples P/(Nb+Ti)/Si and P/Nb/Ti-Si were in amorphous form indicating that Ti and Nb were dispersed well on the surface of silica. UV-Vis DR results revealed that octahedral or polymeric Ti species was the dominant species in sample P/Nb/Ti/Si while hydrated tetrahedral Ti species was predominant in samples P/(Nb+Ti)/Si and P/Nb/Ti-Si. Besides of tetrahedrally coordinated Ti species, it has been demonstrated that the presence of Nb, PO_4^{3-} as well as the SiO_2 support has contributed significantly in improving the oxidative catalytic activity. Meanwhile, interaction between PO_4^{3-} groups and Nb has generated Brönsted acidity for the high yield of diol. It has been shown that P/Nb/Ti-Si was the best bifunctional oxidative-acidic catalystin consecutive transformation of 1-octene to 1,2-octanediol through formation of 1,2-epoxyoctane using aqueous H_2O_2 at 343 K.It was expected that synthetic method used in preparation of P/Nb/Ti-Si has aided the effective interaction between PO_4^{3-} and Nb, leading to formation of more Brönsted acidity in this sample.

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