Synthesis of core-shell metal-ceramic microstructure and glycerol steam reforming

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Heat and mass transfer properties of heterogeneous catalysts are important factors that play a substantial role on their performance in practical applications. However, most supports for catalyst were used low thermal conductive ceramic materials. In this work, we present an effective and direct synthetic protocol for core-shell microstructures consisting of a highly heat conductive Al-metal core with a high surface area crystalline $MeAl_2O_4$ (Me = Mg, Mn, Co, Ni, Zn) spinel oxide shell that can collectively benefit superior heat and mass transport properties. The structures were analysed by N2 adsorption, XRD, XPS, SEM and EDX. In addition, we demonstrate that these core-shell metal-ceramic microstructures facilitate the heat and mass transport required for the catalytic reactions, by using the $MeAl_2O_4$@Al as the support of precious metal Rh catalyst for glycerol steam reforming to hydrogen ($C_3H_8O_3 + 3H_2O \rightleftarrows 3CO_2 + 7H_2$, $\Delta H_{o298} = 128$ kJ mol^{-1}). For comparison, $MeAl_2O_4$ was also prepared by co-precipitation method and also utilized for a catalyst support. In result, Rh/$MgAl_2O_4$@Al exhibited about 1.2 ~ 8 times higher glycerol conversion turnover frequency (TOF) than Rh/$MgAl_2O_4$.