Highly thermal conductive metal-ceramic core-shell microstructure as catalyst materials

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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, the conventional heterogeneous catalysts are mostly constructed on ceramic substrates (Al_2O_3, SiO_2, etc.) with low thermal conductivities and high specific heat capacities.

In this study, we present a 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, Co, Zn, Ni and Mn) spinel oxide shell that can collectively benefit superior heat and mass transport properties. In addition, we report studies on the formation mechanism and characteristics of the spinel- $MeAl_2O_4$@Al (Me = Zn, Ni, Co, Mn, and Mg) with an extensive experimental and theoretical investigation with various period 3-6 metal elements (Na, Ca, Sr, Ba, K, Fe, Cu, Zn, Ni, Co, Mn, and Mg). The effects and performance of the structures were investigated using Rh or Ru supported on structures for glycerol steam reforming and CO-oxidation reaction, which is endothermic or exothermic favoring facile heat flux.