

# 改性 $ZrO_2-MnO_2$ 基整体式催化剂上 $NH_3$ 选择性催化还原 NO

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**摘要** 采用共沉淀法制备了  $ZrO_2-MnO_2$  催化剂, 考察了  $CeO_2$ ,  $MoO_3$  和  $WO_3$  的添加对  $ZrO_2-MnO_2$  整体式催化剂上  $NH_3$  选择性催化还原 ( $NH_3-SCR$ ) $NO_x$  的影响, 并利用低温  $N_2$  吸附-脱附、X 射线衍射、X 射线光电子能谱、 $NH_3$  和 NO 程序升温脱附等方法对催化剂进行了表征. 结果表明催化剂物相为  $Mn_{0.2}Zr_{0.8}O_{1.8}$  固溶体,  $CeO_2$  和  $WO_3$  分散在其中; 添加  $MoO_3$  或  $WO_3$  后, 样品中出现了新的中强酸位, 强吸附的 NO 物种增加, 从而有利于催化剂中高温活性的提高. 另外, Mn 和 Ce 物种主要分别以  $Mn^{4+}$  和  $Ce^{4+}$  形式存在. 在  $NH_3-SCR$  反应中,  $CeO_2$  的添加提高了  $ZrO_2-MnO_2$  催化剂的低温活性, 但反应温度窗口较窄; 继续添加  $MoO_3$  或  $WO_3$  后, 催化剂表现出良好的低温活性和宽的反应温度窗口, 其中  $WO_3/CeO_2/ZrO_2-MnO_2$  催化剂上 NO 的起燃温度为 176 °C, 且反应温度在 240~424 °C 范围内,  $NO_x$  转化率大于 90%, 具有良好的低温活性和宽的温度窗口.

**关键词:** 氮氧化物 选择性催化还原 整体式催化剂 二氧化锆 二氧化锰 氧化铈 三氧化钨

**Abstract:** A  $ZrO_2-MnO_2$  catalyst was prepared by the co-precipitation method, and modified with  $CeO_2$ ,  $MoO_3$ , and  $WO_3$  by impregnation. The catalytic activity of the monolithic catalysts for selective catalytic reduction of  $NO_x$  with  $NH_3$  ( $NH_3-SCR$ ) was studied. All the catalysts were characterized by low temperature nitrogen adsorption-desorption, X-ray diffraction, X-ray photoelectron spectroscopy, and  $NH_3/NO$ -temperature-programmed desorption. The results show that the phase of the catalysts is  $Mn_{0.2}Zr_{0.8}O_{1.8}$  solid solution, and  $CeO_2$  and  $WO_3$  are well dispersed in catalysts. When adding  $MoO_3$  or  $WO_3$  into the catalyst, some medium-strength acid sites and the strongly adsorbed NO species that are beneficial to the elevated temperature catalytic activity increase. Mn and Ce exist as  $Mn^{4+}$  and  $Ce^{4+}$ . The low temperature SCR activity is improved by the modification with  $CeO_2$ , but the temperature window of the reaction is relatively narrow. When  $MoO_3$  or  $WO_3$  is introduced into  $CeO_2/ZrO_2-MnO_2$ , the catalyst exhibits better catalytic performance and wider temperature window. The light-off temperature of  $WO_3/CeO_2/ZrO_2-MnO_2$  is 176 °C, and the  $NO_x$  conversion is over 90% in the temperature range of 240 - 424 °C, and it has good low-temperature activity and wide temperature window.

**Keywords:** nitrogen oxides, selective catalytic reduction, monolithic catalyst, zirconium dioxide, manganese dioxide, cerium oxide, tungsten trioxide

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