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Low temperature catalytic oxidation of NO over different-shaped CeO_2

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Abstract: To investigate the effect of CeO_2 nanomaterial morphology on its performance for NO catalytic oxidation. Three kinds of CeO_2 nanomaterials including CeO_2 nanorods, nanospheres and nanoparticles were prepared by hydrothermal method and used for catalytic oxidation of NO at low temperature. The experimental results show that CeO_2 nanorods are of the bestcatalytic performance. Characterization techniques including TEM, XRD, H_2-TPR, NO-TPD and XPS were used to determine the relationship between the morphology of CeO_2 nanomaterial and its catalytic performance. TEM images show that CeO_2 nanorodspredominantlyexposed (110) and (1 0 0) planes, while CeO_2nanospheres and CeO_2nanoparticlespredominantly exposed (1 1 1) plane. The excellent catalytic performance of CeO_2nanorods could be ascribed to the low crystallinity, high reducibility, strong NO adsorption ability and the presence of more surface chemisorbed oxygen.
Keywords: CeO_2 nanomaterials; catalytic oxidation; NO; characterization; rare earths

1. Introduction

NO_x emitted from the combustion process of fossil fuels is regarded as one of the main precursors of acid rain and photochemical smog[1-3]. During the past several decades, various efforts have been made to reduce NO_x emissions. Among them, selective catalytic reduction (SCR) process has been successfully used for controlling NO_x emitted from stationary sources such as coal-fired power plants, biomass boilers and municipal solid waste (MSW) incinerators due to its high NO_x removal efficiency[4-6]. In this process, NH_3 or urea is usually used as the reducing reagent. But the deactivation of SCR catalyst by SO_2 and some components of the fly ash contained influe gas including alkali metals, alkali earth metals and heavy metals make it necessary to develop new NO_x control techniques[7-10].

It is well known that insoluble NO constitutes more than 90% of NO_x in typical coal-fired flue gas[11, 12]. Due to the low solubility of NO, it cannot be removed effectively by aqueous solution. If NO is converted into soluble NO_2, then it can be removed with SO_2 simultaneously in wet flue gas desulfurization scrubber. In recent decades, many inorganic oxidants such as $NaClO_2$[13], $KMnO_4$[14], ClO_2[15], NaClO[16], $Na_2S_2O_8$[17] and Fenton reagent[18] have been used for NO oxidation in the oxidation-absorption process for NO removal. But the cost of oxidants limits the industrial application of this process.

Besides the liquid phase oxidation-absorption processes mentioned above, NO can also be