Investigation of the active sites and optimum Pd/Al of Pd/ZSM-5 passive NO adsorbers for the cold-start application

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We investigated the chemisorptive NO adsorption ability at a low temperature (120 oC) of the Pd/ZSM-5 passive NOx adsorbers (PNA) to address the cold-start NOx emission. The Pd/ZSM-5 showed a much higher NO adsorption ability after the oxidative treatment at 750 oC compared with the 500 oC treatment; combined EXAFS, XPS and XRD results show that atomically dispersed Pd species were formed over the former, while small PdO agglomerates were observed over the latter. The Pd species on the Pd/ZSM-5 were further examined by applying a NH4NO3-titration method, where an ion exchange occurred with only the ionic-Pd species, and this resulted in a decreased NO adsorption capability. The combined results indicate that the ionic-Pd species are the active sites for the chemisorptive NO adsorption. The NO adsorption capability was also investigated as a function of the Pd loading and the Si-to-Al2 molar ratio of the ZSM-5. The optimum Pd-to-Al molar ratio existed for the Pd/ZSM-5 with the maximum NO adsorption capability, which was found at around 0.25, thereby suggesting that the Al in the ZSM-5 framework led to the high dispersion of the ionic-Pd species up to the optimum Pd/Al ratio.