XANES Investigation of the Fe in the Particulate Matter Emitted from Motorcycle

Shu-Mei Chien (簡淑美) and Yuh-Jeen Huang (黃鈺軫)

Department of Biomedical Engineering and Environmental Sciences, National Tsing Hua University, Hsinchu, Taiwan

Catalytic converters are widely applied to control automotive emissions, such as nitrogen oxides (NOx), carbon monoxide (CO), and unburned hydrocarbons (HC)[1-3]. Currently, three-way catalysts (TWC) has widely been used in motor vehicles. These conventional catalysts are finely divided precious metal particles dispersed on ceramic-support materials. The converter is exposed to heat during vehicle use, and its catalytic activity deteriorates, because the agglomeration and growth of the precious metal particles reduces their overall surface area. Conventional catalyst systems thus employ a sufficient excess of precious metals to ensure the activity for long-term vehicle use. Regulations of automobile emissions are being strengthened with the years on a worldwide scale for global and regional environmental protection. New system for automotive catalyst is expected to conserve precious materials without diminishing high efficiency.

However, after cessation of engine combustion process, some unburn mixing gas still remained in the engine or exhaust pipe and resulted in the adsorption of iron oxides from the corrosion of pipe on the suspended particles. The size distributions of the particles were measured using an ELPI (Dekati, Ltd.) equipped with aluminum foil (diameter: 37 mm) to collect size-resolved aerosol samples. The instrument sampled air at a nominal flow rate of 10 L min^{-1}. The ELPI had three main components: a cascade impactor, a unipolar diode charger, and a multichannel electrometer. It was used to simultaneously measure the charges carried by the collected particles at each stage. Accordingly, the particles were divided into four size groups: nano (0.03 μm ≤ d_p < 0.09 μm), ultrafine (0.17 μm ≤ d_p < 0.38 μm), fine (0.65 μm ≤ d_p < 1.61 μm), and coarse (2.50 μm ≤ d_p < 9.97 μm). The X-ray absorption measurements on the Fe K-edge was carried out with synchrotron radiation at the 01C beam line.

The speed condition of a motorcycle might affect the size and formation of particles in the exhaust. Figure 1 presents the particle size distributions of the particles emitted from the 4-st mc^{-1} at Idle condiation. The XANES spectra of coarse, fine, ultrafine and nano particulate fitted by three standardscompound, incuding Fe_2O_3, Fe_3O_4 and FeOOH, were shown that, the ratio of Fe_2O_3 species were 76.1%, 64.2%, 56.6% and 61.6%, respectively; the ratio of Fe_3O_4 species were 17.3%, 31.8%, 41.0% and 20.6%, respectively; and the ratio of FeOOH species were 6.66%, 3.98%, 2.44% and 17.8%, respectively.

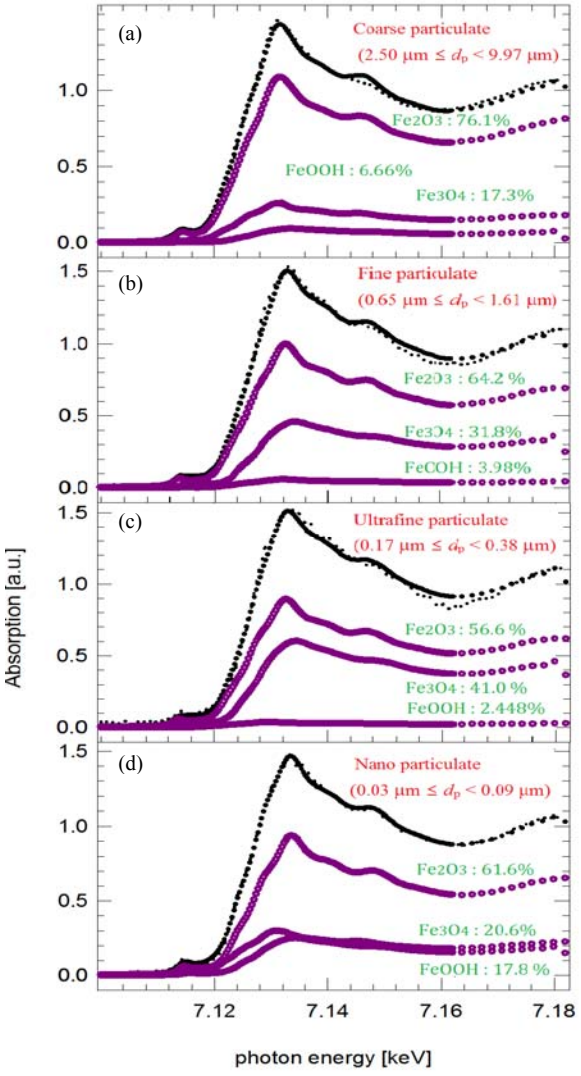

Fig. 1: XANES spectra of (a) Coarse particulate, (b) Fine particulate, (c) Ultrafine particulate, (d) Nano particulate emitted from the 4-st mc^{-1} at Idle condiation.

[1] E. S. J. Lox and B. H. Engler, Environmental Catalysis, Wiley-VCH (1999).
[2] A. Trovarelli, Catal. Rev. Sci. Eng. **38** (1996).
[3] G. Djega-Mariadassou, F. Fajardie, J. F. Tempere, J. M. Manolo, O. Touret, and G. Blanchard, J. Mol. Catal. A **161** (2000).