From 2-D to 3-D morphology and elemental oxidation states of individual aerosols

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Abstract

Ambient aerosols adversely affect the environment and human health. Less known, though, are the 3-D morphology and elemental oxidation states and of aerosols, of which are expected to modify the resulting impacts. Thus, the aim of our research is to explore the external/internal structures and elemental oxidation states of individual aerosols, using transmission electron microscopy (TEM), synchrotron-based transmission X-ray microscope (TXM; TLS 01B1) and X-ray Nanoprobe (XNP; TPS 23A1). Results show that individual aerosols have various internal structures evident in TXM 3-D images, despite the apparent similarity in external appearance shown in TEM 2-D images. For example, some spherical particles appear as opaque or solid particles, whereas others show porous or exhibit core-shell structure. In XNP with X-ray fluorescence (XRF), various elements were identified and found to be heterogeneously distributed among individual aerosols. The identified elements were then subjected to X-ray absorption near edge structure (XANES) for their oxidation states. The overall outputs are expected to provide advanced knowledge of the morphology and elemental oxidation states of aerosols that is crucial for public and environmental health protection.

Keywords – $PM_{2.5}$, Morphology, Oxidation state, X-ray microscopy, X-ray spectroscopy, transmission electron microscopy

References

[1] Liu, Lei, et al. Morphology, composition, and mixing state of primary particles from combustion sources—crop residue, wood, and solid waste. Scientific reports 7.1 (2017): 1-15.

[2] Maskey, Shila, et al. Morphological and elemental properties of urban aerosols among PM events and different traffic systems. Journal of Hazardous Materials 317 (2016): 108-118.

[3] Linak, William P., et al. Ultrafine ash aerosols from coal combustion: Characterization and health effects. Proceedings of the Combustion Institute 31.2 (2007): 1929-1937.

[4] Li, Weijun, et al. A review of single aerosol particle studies in the atmosphere of East Asia: morphology, mixing state, source, and heterogeneous reactions. Journal of Cleaner Production 112 (2016): 1330-1349