Decomposition of Poly-cyclic Aromatic Hydrocarbons (PAHs) in Smoke Particles from Biomass Burning by Soft X-Ray Irradiation

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1. Introduction
The soft X-ray emitted from a commercially available soft X-ray bulb was applied to test its possibility as an effective device for the decomposition of poly-cyclic aromatic hydrocarbons (PAHs), typical hazardous and carcinogenic pollutants emitted from the biomass burning¹). Both size fractionated and all smoke particles after being irradiated by the soft X-ray were collected on quartz fiber filters to discuss the effect of the soft X-ray irradiation on particle-bound PAHs concentration.

2. Experimental Setup and Procedure
Fig. 1 shows the experimental setup, which consists of a wood burning oven, a 3-m-high chimney, a soft X-ray irradiation chamber, two sets of orifice and manometer for the flow rate measurement, two sets of cascade impactors and a vacuum cleaner as an air pump. A portion of flue gas from rubberwood burning was introduced to the irradiation chamber at a constant flow rate (28.3 L/min). Sized smoke particles were collected on quartz fiber filters. The soft X-ray tube (Hamamatsu Photonics Photo Ionizer L6941, wave length = 1.3X10⁻⁴ ~ 4.1X10⁻⁴ µm, the average intensity of 4.4keV at 4cm distance) was attached to the top of the chamber consisting of T-shaped steel tubing covered with a PVC shield with a thickness of 6 mm. In order to avoid the direct contact of flue gas and water vapor to the soft X-ray bulb surface, the top end of T-tubing is covered by a polyimide film.

Fifteen different PAHs (Nap, Ace, Phe, Ant, Fle, Flu, Pyr, BaA, Chr, BaP, BbF, BkF, DbA, IDP and BghiPe) were analyzed using an HPLC with a fluorescence detector + acetonitril/ultra pure water mobile phase after ultrasonically dissolving the samples on the filter in an ethanol/benzene (1:3) solution and evaporation with a rotary vacuum evaporator.

4. Results and Discussion
Fig. 2 shows the mass fraction of total PAHs with 2-6 rings defined as total collected particulates for both soft X-ray irradiated and non-irradiated samples. The mass fraction of every PAH compositions was decreased by an average of ca. 30% after the soft X-ray irradiation. Fig. 3 shows the relation between particle size and decomposed fractions of PAHs with 2-3, 4 and 5-6 rings. Regardless of the composition, the decomposition increased as the particle size decreased. Larger fractions of PAHs with 5-6 rings were decomposed.

References