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First workshop on indoor air pollution and advanced air pollution control technologies Kumamoto, Japan, January 8—11, 2016

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The First Workshop on Indoor Air Pollution and Control was held in Kumamoto, Japan, and its success was due in large measure to the efforts of the local host Prof. Daizhou Zhang from Prefectural University of Kumamoto and his students. The workshop was sponsored by the China Association of Aerosol Science and Technology (CAAST), the Air & Waste Management Association-China Chapter (A&WMA-China), the Institute of Earth Environment, Chinese Academy of Sciences, the Institute of Atmospheric Physics, Chinese Academy of Sciences, and the Asian Aerosol Research Assembly (AARA). The meeting highlighted the research of scientists from Japan, the Chinese mainland, the Hong Kong of China, and the Taiwan of China, and its goals of collaboration and exchange were achieved. The workshop was attended by approximately 30 delegates from Chinese Academy of Sciences (CAS), the Prefectural University of Kumamoto, the National Institute of Advanced Industrial Science and Technology (AIST), and other renowned Japanese, Chinese mainland, and the Taiwan of China's universities and institutions. The opening remarks were given by Prof. Norikazu Namiki and Prof. Junji Cao. The quality of the presentations and discussions was excellent; the talks were formatted as PowerPoint™ files and shared among all presenters.

The goals of the workshop were (1) to initiate communications and facilitate cooperation among scientists on air pollution control, especially indoor environments, and on air purification techniques; and (2) to establish channels for collaboration in relevant fields between research organizations and foundations as well as among scientists. This workshop provided important opportunities for delegates from different fields and backgrounds to become acquainted, and it promoted long-term partnerships among top scientists in a variety of fields.

The panel titles and lead scientists were: Panel 1, Indoor Air Quality and Control Technologies, Shiji Fuji, Junji Cao, and Koji Takeuchi; Panel 2, Outdoor Atmospheric Environment, Renjian Zhang; Panel 3, Environmental Science and Technology, Koji Arizono. The Second Workshop on Indoor Air Quality and Control is planned to be held at the Institute of Earth Environment, Xi'an, China in September, 2016.

Panel 1: Summary of indoor air quality and control technologies (Shiji FUJI, Junji CAO, and Koji TAKEUCHI)

China now faces some of the most severe air pollution issues in the world; and through the exchange of outdoor air, the penetration of pollutant aerosols into indoor environments is inevitable, and much remains to be learned about the sources for indoor air pollutants. Indoor air quality deserves special attention due to the high exposure risks associated with confined spaces. Experts from Kogakuin University, the Tokyo Institute of Technology, and the Shibaura Institute of Technology focused this session on indoor aerosol formation and modeling. Although the indoor/outdoor (I/O) ratio of $PM_{2.5}$ is commonly used as a measure of indoor air quality and does provide some useful information, it was suggested that the particle size distributions of indoor aerosols also should be monitored. Office machines—especially laser printers—are one of the primary indoor source for ultrafine particles, and air filters with fine fibers have been proven to effectively suppress the dispersion of particles from these sources.

As one of the most promising technologies for improving indoor air quality, air cleaning systems have been receiving increased attention worldwide. In this context, Shuji Fuji from Kanazawa Institute of Technology

introduced the "Guideline for performance evaluation of air cleaners" and emphasized the advantages of establishing these types of measures to promote technical progress. Moreover, panel members from various universities and institutes had expertise in applying non-thermal plasmas, photocatalysis, and other technologies to the control of gaseous pollutants, and those topics also were considered.

The panel also discussed advanced air quality and control technologies, especially those involving the use of photocatalysis. Both China and Japan have conducted extensive field tests on cleaning polluted air with immobilized photocatalysts, and twenty years of research into practical applications has shown that photocatalytic materials can remove pollutants from the air and in so doing reduce the risks for human health. The efficiency of this technology has been limited by several factors: first, poor contact between the photocatalysts and the air to be treated; and second, the limitations of visible light. In laboratory studies, extensive efforts have been dedicated to the development of visible-light sensitive photocatalysts, such as g-C_3N_4 and bismuth-based nanomaterials.

For open-air applications, dust deposition onto photocatalysts negatively affects their activity, and therefore it has been recommended that materials with self-cleaning surface properties should be developed. Koji Takeuchi (National Institute of Advanced Industrial Science and Technology) has developed photocatalytic demonstration units for air quality improvement, and there are major funding resources for addressing air pollution in China. As a result, it is now a strategic time for developing joint projects on air quality improvement, and determined efforts should be made to promote research cooperation between Japan and China.

Specific recommendations for collaboration also were developed, and several practical concepts proposed. One idea was to encourage academic and technical exchange between graduate students and senior researchers through scholarships and research support. Another idea was to submit joint proposals that focus on indoor air pollution and advanced control technologies for ambient air. With funding in hand, it will be possible to initiate the research and set clear goals for addressing air pollution problems.

More experts and new companies also can be engaged to enhance the influence of workshops such as this one. For example, Toto Co., Ltd in Japan has used photocatalytic technology in their products; and cooperative programs could be established between research institutions and companies such as Toto to promote the commercial applications of research findings. Patents also can be transferred to interested companies so that advanced technologies would benefit more areas of the world. Some questions and issues also were raised concerning the scope of advanced technologies. It was suggested, for example, that the priorities should be defined in ways that would focus efforts on the most promising research topics.

Panel 2: Summary of outdoor atmospheric environment (Renjian ZHANG)

The Atmospheric Environment Panel included a group of scholars who specialize in various topics concerning atmospheric aerosols, including their impact on outdoor air quality and human health. Yafen Wang (Chung Yuan Christian University) presented results showing that air toxics in Taiwan mainly originate from traffic sources and that stricter vehicle emission standards have been adopted by the Environmental Protection Agency (EPA) of Taiwan. Health effects also will be considered in Taiwan's Pollutant Standards Index, and that should lead to a more comprehensive understanding of the applications possible for the environmental monitoring programs.

The sources and processes leading to the formation of $PM_{2.5}$ in China are complex, and yet they must be thoroughly understood before it will become possible to design effective control systems, and several examples of studies in this area were presented. For example, Renjian Zhang conducted studies that for the first time explored the chemical composition and sources of $PM_{2.5}$ in Beijing from the perspective of seasonal change. Feng Wu and Yunfei Wu analyzed variations in the loadings of water-soluble iron and the black carbon aerosol, and they correlated those patterns with the haze formation. Steven Sai Hang Ho studied the behavior of glyoxal, one of the most important reactive species that contributes to the formation of secondary organic aerosol in the atmosphere. Tomoko Kojima

investigated the aerosol following a volcanic eruption and assessed its impact on the air quality of Kumamoto.

Panel 3: Summary of environmental science and technology (Koji ARIZONO)

In addition to the sophisticated instruments now used for environmental monitoring, rapid and simple bioassays hold great promise for investigating contamination by pollutants, including dioxins and hormones. These substances are increasingly emitted into the environment from construction activities, waste burning, and as components of bio-medical wastes. A national database for some of these compounds already exists in Japan, and relevant regulations are being considered. These concepts should be further developed within the framework of air pollution control because this type of monitoring is both practical and of critical significance to human and ecosystem health.

In the pursuit of sustainable development, the choices we make now in terms of resource utilization may well have important consequences for the future. For example, biomass can continue to be burned as it is now, but it also can be fermented to produce methane using available technologies. Such forward thinking may not only provide us with clean energy by converting organic wastes to a valuable fuel, but also have benefits in terms of energy recovery as well as environmental protection. Indeed, to better our living environment, we need to seriously consider how best to use our limited resources and how to maintain the ecological balance.

(From left to right)
Row 3: Azuchi HARANO, Yasuhiro ISHIBASHI, Tetsuro AGUSA, Shengjie YOU, Yunfei WU, Wing Kei HO, Yu HUANG, Zhenyu WANG, Shinichiro FUKUYAMA, Kotaro MURATA.
Row 2: Xiaofeng XIE, Feng WU, Jingxian LIU, Steven Sai Hang HO, Renjian ZHANG, Junji CAO, Koji ARIZONO, Koji TAKEUCHI, Daizhou ZHANG, Ayumi NAGANUMA.
Row 1: Jing SUN, Tomoko KOJIMA, Qian ZHANG, Zhihui AI, Wei WANG, Yan LI, Yafen WANG, Yanfeng LU, Satoshi FUKUSHIMA, Miki MIYAMOTO, Kaho YAMAGUCHI.