

Title: Development of the Science and Technology of Carbon-Neutral Combustion Systems: The Case of Ammonia Fuel

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Combustion plays a central role in the global energy supply and will continue to serve as an important energy-conversion process in domestic, transportation, and industrial applications. The advancement of the science and technology of carbon-neutral combustion is therefore essential for achieving a carbon-neutral society.

Ammonia is both a promising hydrogen carrier and a carbon-free fuel, with considerable potential for application in carbon-neutral internal combustion engines, gas turbines, industrial furnaces, and other energy-conversion systems. However, ammonia combustion presents formidable scientific and technological challenges, including low reactivity, low flame speed, limited flame stability, and the formation of nitrogen-containing pollutants. These challenges discouraged the widespread use of ammonia as a fuel in earlier decades.

This presentation will review my pioneering efforts to establish the fundamental science of ammonia combustion and translate this knowledge into practical combustion technologies, with particular emphasis on gas-turbine combustors. Beginning with the Cross-ministerial Strategic Innovation Promotion Program (SIP) “Energy Carriers” project, the presentation focus on key advances in fundamental combustion characteristics, chemical kinetics, flame stabilization, pollutant formation and control, burner design, and liquid-ammonia combustion. The presentation will also highlight the remaining challenges and future research directions required to enable the safe, efficient, and environmentally responsible deployment of ammonia-fuelled combustion systems.