Tokyo Tech Research Units

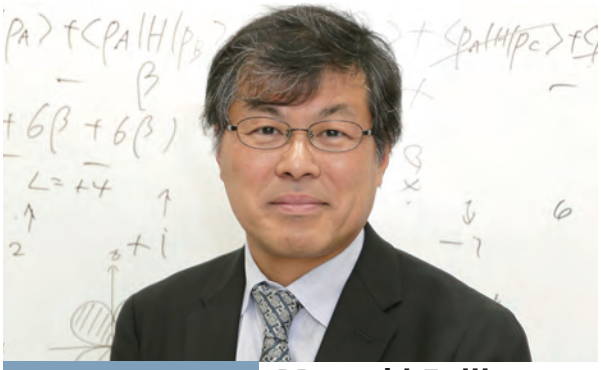
Clean Environment Unit

Overview

The Clean Environment Unit works on the real-time detection of airborne substances which cause environmental pollution. By understanding the distribution and severity of pollution, and by clarifying its causes, the unit aims to realize a clean environment. Specifically, it promotes research utilizing resonance-enhanced multiphoton ionization (REMPI), detecting and analyzing a wide range of hazardous substances such as PM 2.5 and automobile exhaust in the atmosphere. The unit also applies the technology to analysis of materials and promotes its use in material sciences. Based on its fundamental research findings, the Clean Environment Unit also develops and improves apparatus in which REMPI is employed.

Research goals

Identification of substances in the atmosphere requires complicated pretreatment such as separation by chromatography and concentration by solvent evaporation. However, REMPI makes it possible to ionize the substances to be identified by adjusting the wavelength of the laser light, enabling detection in real time. This is called *resonance enhancement*, which the unit can apply to the analysis of constituents of solid materials by vaporizing them with focused ion beams. The Clean Environment Unit further promotes fundamental research aiming to improve the sensitivity and resolution of REMPI. The unit also works on the commercialization of supersensitive solid material analysis apparatus utilizing REMPI for application in the analysis of radioactive elements in Fukushima, and material analysis of semiconductors and steel.



Research Unit Leader **Masaaki Fujii**

Profile

2016 Professor, Institute of Innovative Research, Tokyo Institute of Technology
2014 President of Japan Society for Molecular Science
2014 Trustee of the Spectroscopical Society of Japan (until present)
2003 Professor, Chemical Resources Laboratory, Tokyo Institute of Technology
1999 Director, Laser Research Center for Molecular Science, Institute for Molecular Science, Okazaki National Research Institutes
1997 Professor, Institute for Molecular Science, Okazaki National Research Institutes
1993 Associate Professor, Department of Chemistry, School of Science and Engineering, Waseda University
1993 Researcher, Precursory Research for Embryonic Science and Technology 21 (Light and Material area), Japan Science and Technology Agency
1988 Visiting scientist under US-Japan Collaboration on Solar Energy, Cornell University
1987 Doctor of Science, Tohoku University
1985 Research Associate, Department of Chemistry, Faculty of Science, Tohoku University
1985 Withdrew from doctoral degree program with full credits, Department of Chemistry, Graduate School of Science, Tohoku University
1982 Bachelor of Science, Department of Chemistry, Faculty of Science, Tohoku University

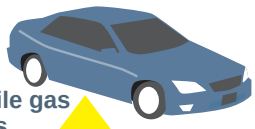
Unit members

- Adjunct Associate Professor Shun-ichi Ishiuchi
- Assistant Professor Mitsuhiko Miyazaki
- Professor Tetsuo Sakamoto, Kogakuin University

Laser multiphoton ionization analysis

Combustion furnace gas analysis & active operation control

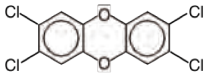
Large-size furnace : 1740 units in Japan



Automobile gas emissions

Laser ionization analysis utilizing REMPI

Atmospheric and environmental analysis



(Environment, disaster prevention)

Expansion to fine particle history analysis, transboundary pollution, and material analysis

Expanding new technology created through Tokyo Tech's fundamental research to environmental and material analysis

Q Why was this research unit established?

We established the Clean Environment Unit to expand new technology created by fundamental research at Tokyo Tech to environmental and material analysis. Although we can conduct fundamental research such as the development of measurement technology and apparatus at universities, it is essential to apply the technology in cooperation with companies and other universities both at home and abroad to return benefits to society. The unit engages in joint domestic and overseas projects and industry-university collaboration in a full and organic manner to develop useful apparatus.

Q What are the strengths of this research unit?

REMPI has been developed in the field of physical chemistry, and application of this technology to analytical chemistry allows us to detect constituents that we want to observe by adjusting the wavelength of laser light without the need for chemical processing such as extraction and concentration. Compared with existing measurement methods, the sensitivity is significantly higher, about 100 million times higher, making it capable of detecting at the atomic and molecular levels. The greatest advantage is that REMPI technology can be utilized in both fundamental research and applications. The unit can advance research by making use of the existing network of specialists and companies in a wide range of areas such as analysis of the atmosphere, environment, automobile exhaust, and materials. It may also be useful in collaborative medicine-engineering research in areas such as cancer screening through breath analysis.

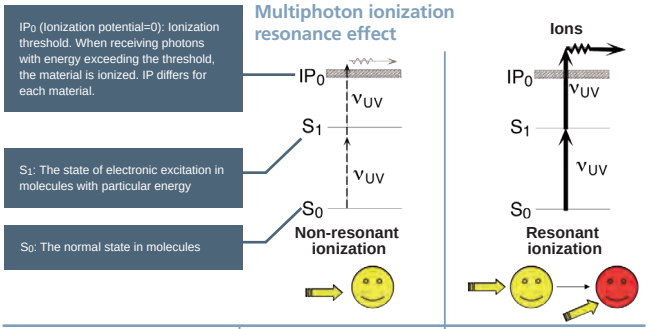
Mechanism of resonance-enhanced multiphoton ionization

IP_0 (IP_0 (Ionization potential=0): Ionization threshold. When receiving photons with energy exceeding the threshold, the material is ionized. IP differs for each material.

S_1: The state of electronic excitation in molecules with particular energy

S_0: The normal state in molecules

Multiphoton ionization resonance effect



Collision of two photons and molecules	Simultaneously	Separately
Generated ions	Low incidence	Very high incidence
	Because a laser at non-resonant wavelength does not cause electronic excitation (S_1), ionization (IP_0) requires radiation with two photons simultaneously	When laser at resonant wavelength is applied, the material becomes metastable in a state of electronic excitation (S_1), generating ionization (IP_0) even when photon energy is received with a time gap.

Q What is the path to achieving the unit's goals?

The Clean Environment Unit sets the goal of commercializing single particle history analysis apparatus. In cooperation with specialists in environmental sciences, the unit analyzes fine particulates in the atmosphere to clarify cross-border transport that may cause global warming and environmental pollution, and creates useful apparatus to understand the impact of these phenomena. We also develop new apparatus to handle materials that are difficult to analyze with existing devices, and conduct detailed analyses at high sensitivity and resolution targeting broader subjects of measurement.

Contact us

Tokyo Institute of Technology
Clean Environment Unit

R1 Building 3 Floor
4259 Nagatsuta-cho, Midori-ku, Yokohama, Kanagawa 226-8502 Japan
Tel : +81-45-924-5250 Email : mfujii@res.titech.ac.jp
www.csd.res.titech.ac.jp/indexj.html