DP012-E207

SHIMADZU
Excellence in Science

For the Earth, For the Future

–Shimadzu Environmental Analytical and Measuring Instruments–

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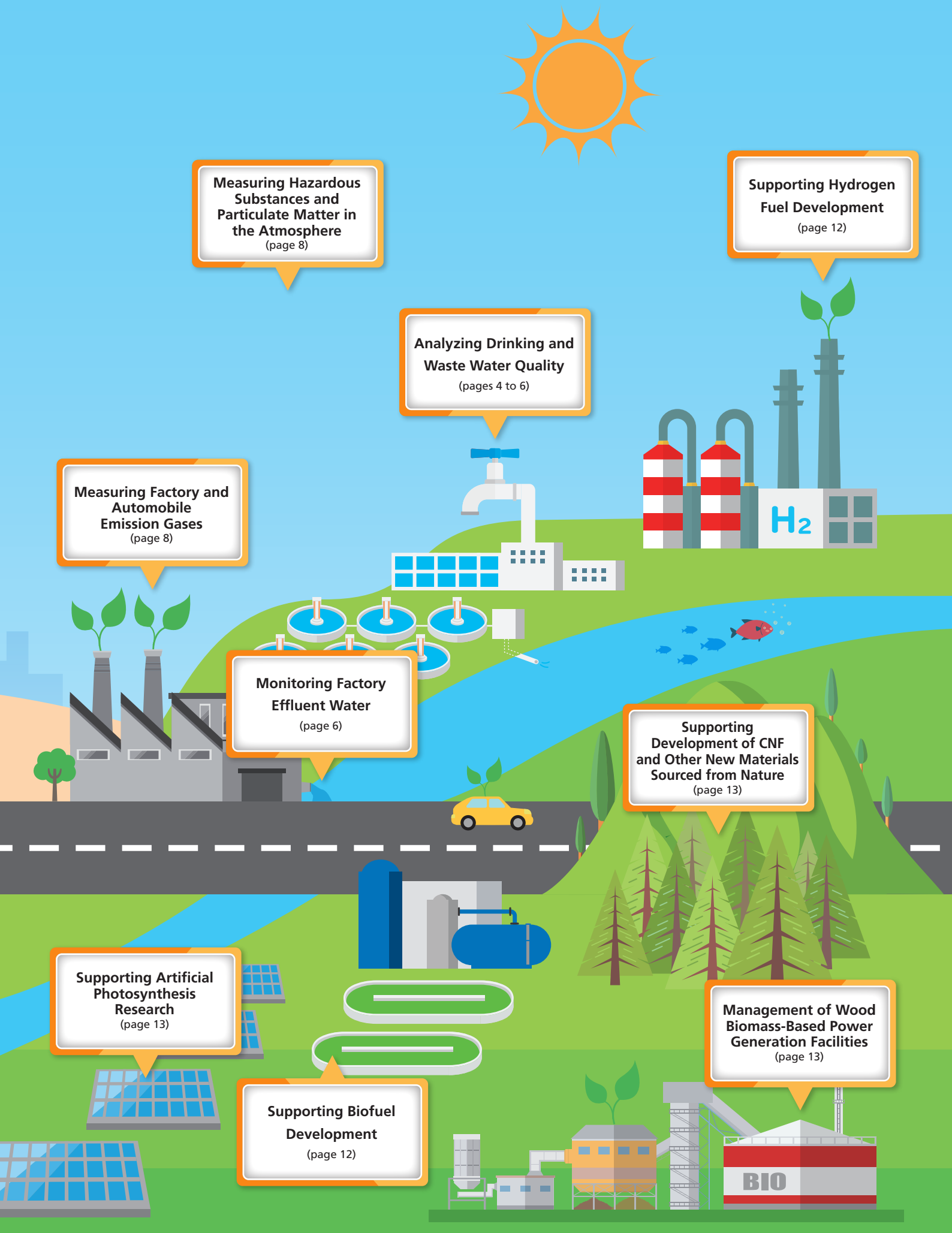
Rapid global economic and societal growth and development have resulted in problems with large storms, flooding, and other natural disasters from climate change and problems with environmental pollution from large quantities of waste and hazardous substances. At Shimadzu, in an effort to help solve environmental challenges and achieve SDGs,* we contribute to establishing a sustainable society by offering a wide variety of instruments and services for analyzing and measuring the environment.

SUSTAINABLE DEVELOPMENT GOALS

* SDGs is an acronym for sustainable development goals. It refers to 17 shared goals to be achieved collectively by the international community by 2030 for establishing a sustainable better world, such as goals for improving human health and addressing climate change.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BIO

Ensuring Safe and Secure Water Supplies

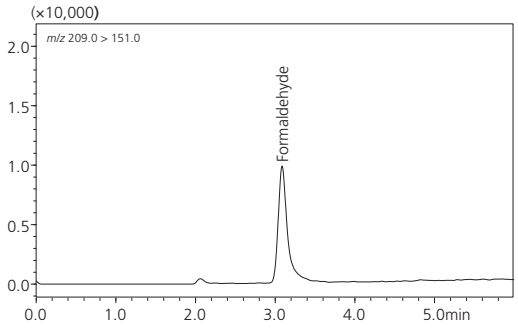
Drinking Water

Given that drinking water quality standards are specified by individual countries, Shimadzu contributes to supplying safe and secure drinking water by providing analytical and measuring instruments and services for testing drinking water.

Formaldehyde, Haloacetic Acids, and Phenols

Formaldehyde, haloacetic acids, and phenols are disinfection by-products generated from reactions between organic matter in the source water and chlorine in the disinfectant. Water quality standards for those compounds are specified based on their toxicity. Liquid chromatograph or liquid chromatograph mass spectrometer systems capable of high sensitivity analysis are used to analyze such components.

Liquid Chromatograph Mass Spectrometer
LCMS-8060

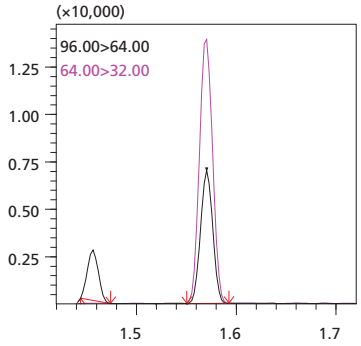


MRM Chromatogram of a Formaldehyde Standard Solution (10 µg/L)

Volatile Organic Compounds (VOCs) and Moldy Odors

Gas chromatograph mass spectrometer (GC-MS) systems are instruments used to analyze a wide range of components, including VOCs and substances that cause moldy odors. Shimadzu also offers various instruments for pretreating samples to improve analysis efficiency based on component characteristics. Such pretreatment equipment can enable simultaneous analysis of multiple components or highly sensitive and selective analysis of trace components, as required for water quality analysis.

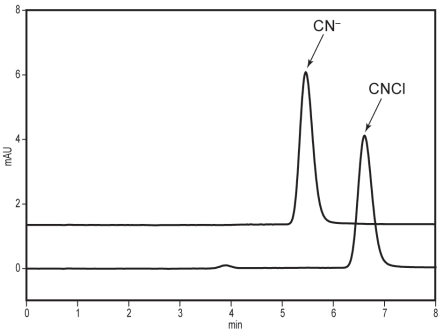
Gas Chromatograph Mass Spectrometer
GCMS-TQ8050 NX



MRM Chromatogram of 1,4-Dioxane-d8

Cyanide Ions, Chloric Acid, and Bromic Acid

Cyanide is commonly used in plating, steel manufacturing, and chemical synthesis processes, but is very toxic. Chloric and bromic acids are also toxic and carcinogenic as well. These substances are analyzed using an ion chromatograph. Shimadzu offers ion chromatograph systems that can analyze cyanide and bromic acid very quickly and with high sensitivity.



Chromatograms of Cyanide Ion and Cyanogen Chloride Standard Samples

Ion Chromatograph
HIC-ESP

Heavy Metals

In drinking water testing, several heavy metals, such as sodium, calcium, and other elements present in high concentrations (mg/L or higher levels) and also lead, cadmium, and other elements only present in low concentrations, are analyzed. Lead can cause anemia, changes in blood, neurological impairments, or gastrointestinal impairments, whereas cadmium can cause kidney failure, osteomalacia, or other toxicity disorders. Such heavy metals can be analyzed by ICP-MS, ICP atomic emission spectrometry, or atomic absorption (AA) spectrometry, but ICP-MS is best for simultaneous analysis of samples that contain trace elements.

Inductively Coupled Plasma Mass Spectrometer
ICPMS-2030

Total Organic Carbon (TOC)

Total organic carbon analyzers are used to evaluate the content of organic pollutants in samples by measuring the quantity of carbon dioxide generated from oxidizing organic matter contained in water. Boasting the highest global market share and trust earned from an extensive track record over many years, Shimadzu TOC analyzers contribute to ensuring the water quality of society.

Total Organic Carbon Analyzer
TOC-L

Keeping an Eye on Water Environments

Effluent Water

Monitoring water outflows from factories and daily living is very important for preventing water pollution. In particular, effluents from business operations that discharge water contaminated with hazardous substances harmful to our living environment must be managed according to strict standards.

Organic Phosphorus Compounds

Organic phosphorus compounds, which occur from organophosphorus pesticides or factory effluent water, can cause eutrophication due to an accumulation of phosphorus in lakes, ponds, or other closed bodies of water. Organic phosphorus compounds can be analyzed with high sensitivity using a gas chromatograph equipped with a flame photometric detector that can selectively detect phosphor compounds.

Gas Chromatograph
GC-2030

Alkyl Mercury Compounds

Due to the lipophilicity of highly toxic alkyl mercury compounds, they tend to concentrate in biological organisms and can cause central nervous system disorders in humans if ingested in high concentrations. Alkyl mercury compounds can be analyzed with high sensitivity and selectivity using a gas chromatograph mass spectrometer (GC-MS).

Gas Chromatograph Mass Spectrometer with Headspace System
GCMS-TQ8050 NX

On-Line Water Quality Analyzers

Not all effluent water quality analysis is conducted in a laboratory. On-line analyzers are also used to continuously monitor factory effluents. Shimadzu offers TOC, TNP, and other on-line analyzers for monitoring effluent water. Shimadzu also offers the maintenance services of instruments utilizing cloud system with TNP-4200 series, on-line total nitrogen and total phosphorus analyzers.

On-Line Total Organic Carbon Analyzer
TOC-4200

River Water and Seawater

It is also important to appropriately test the water quality of rivers, lakes, and seawater based on environmental standards specified for protecting human health and living environments. Shimadzu contributes to ensuring the safety of environmental waters by supplying analytical and measuring instruments for testing whether they meet specified water quality standards.

Volatile Organic Compounds (VOCs)

Benzene, dichloromethane, trichloroethylene, and other volatile organic compounds are organic pollutants that are harmful to our health. To prevent pollution of water environments, respective countries have specified environmental standards for drinking water, effluent water, and environmental waters.
VOCs are analyzed using a gas chromatograph mass spectrometer. Shimadzu offers the main pretreatment equipments used for measuring VOCs, such as headspace systems and purge and trap systems.

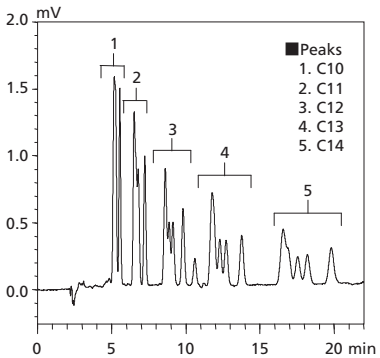
Headspace - Gas Chromatograph Mass Spectrometer

Purge and Trap System

Surfactants

Most of the surfactants produced as ingredients for detergents and other products are either non-ionic or anionic, but due to the large quantities used, they are often detected in the environment. In particular, anionic surfactants, which originate from sources such as factory effluents and residential wastewater and can cause foaming when present in water, serve as an important pollution indicator. Such surfactants are analyzed using a liquid chromatograph or a liquid chromatograph mass spectrometer.

Ultra High Performance Liquid Chromatograph
Nexera



Chromatogram of Five Anionic Surfactants
(0.04 mg/L each, for a total 0.2 mg/L)

Keeping an Eye on Atmospheric Environments

Atmosphere

Given that air pollution is caused by hazardous substances, particulates, and other substances contained in factory emissions, automotive exhaust emissions, and so on, it is important to monitor the pollutants in such pollution sources. Shimadzu contributes to atmospheric environmental protection by developing and supplying relevant analytical and measuring instruments.

Volatile Organic Compounds (VOCs)

Measuring the concentration of VOCs in the air serves as a means of determining the air pollution level and is used to monitor pollution in a wide variety of environments, such as within factories, urban areas, and indoor environments. Atmospheric VOC levels are typically analyzed using a thermal desorption gas chromatograph mass spectrometer (TD-GC/MS) system.

Thermal Desorption - Gas Chromatograph Mass Spectrometer

Aldehydes

Aldehydes in the atmosphere are hazardous substances that can cause air pollution. Due to the risk of harm to human health from extended exposures, it is very important to analyze them. As one cause of sick house syndrome, aldehydes are measured in indoor environments. Such substances are analyzed using a liquid chromatograph.

Ultra High Performance Liquid Chromatograph
Nexera

Fine Particulate Matter (PM2.5) in Air

"PM2.5" refers to airborne particles with a diameter of 2.5 μm or less, which are prone to entering deep into human lungs and are thought to have a significant effect on health. Based on the Japanese Air Pollution Control Act, a wide variety of analytical instruments are used to analyze PM2.5 components.

Polycyclic Aromatic Hydrocarbons (PAH)

Ultra High Performance Liquid Chromatograph
Nexera

Inorganic Elemental Components

X-Ray Fluorescence Spectrometer
EDX-7000/8000

Water Soluble Organic Carbon

Total Organic Carbon Analyzer
TOC-L

Ionic Components

Ion Chromatograph
HIC-ESP

Ensuring the Safety of Soil

Contribution to SDGs!

Soil

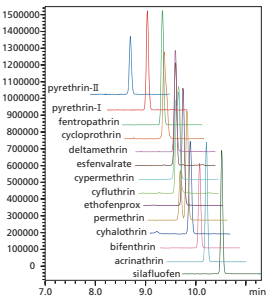
Soil pollution occurs when heavy metals, organic solvents, or other hazardous substances are leaked from factories that use those substances or inappropriately buried, for example. Shimadzu contributes to the protection of soil environments by developing and supplying relevant analytical and measuring instruments.

Residual Pesticides

There is concern that some components in agricultural pesticides tend to remain in the soil, which results in substances remaining in the ecosystem and food chain. Multiple residual pesticides can be analyzed simultaneously using a gas chromatograph mass spectrometer or a liquid chromatograph mass spectrometer.

Database for Supporting Residual Pesticide Analysis

Liquid Chromatograph Mass Spectrometer
LCMS-8060



Example of Detecting Pyrethroid Pesticide Peaks

Hazardous Metals

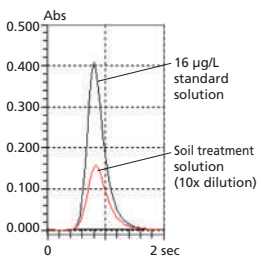
In an effort to prevent soil pollution, criteria values have been specified so that concentrations of hazardous metals in soil remain below certain levels. An ICP atomic emission spectrometer is typically used to analyze hazardous metals in soil, because it can analyze trace quantities of hazardous metals efficiently.

ICP Atomic Emission Spectrometer
ICPE-9800

Metals

Both ICP atomic emission spectrometers and atomic absorption spectrophotometers (AA) are typical instruments used for elemental analysis. When the number of metal elements to be measured is small, AA is more suitable because it is easier in the procedure.

Atomic Absorption Spectrophotometer
AA-7000



Peak Profile of Cesium Standard Solution and Soil Treatment Solution

Achieving a Safe and Prosperous Recycling-Oriented Society

Waste and Hazardous Substances

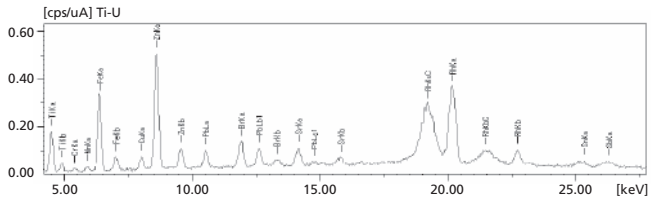
Shimadzu contributes in the field of waste management and recycling as well. In order to recycle waste plastic materials, it is important to sort the materials accurately. Analyzing chemical components in mud, gravel, and other materials is essential for appropriately managing those materials as industrial waste. Marine microplastics have also become a major environmental problem. Shimadzu contributes to building a recycling-oriented society by developing and supplying relevant analytical and measuring instruments.

Analysis of Incineration Ash from City Waste and Sewage

In Japan, incinerated waste from cities is normally buried as specially managed general waste, whereas buried sewage incineration ash is handled as industrial waste. However, in terms of environmental protection, both must be tested to determine the content of heavy metals. An ICP atomic emission spectrometer can accurately quantitate the levels of lead, cadmium, and other metals present in a wide range of concentrations, from trace to high concentration, whereas an X-ray fluorescence spectrometer (EDX) can be used to manage the concentration levels of the main components in combustion ash, such as calcium, silicon, and aluminum, or provide simple detection/quantitation of hazardous heavy metals such as lead.

ICP Atomic Emission Spectrometer
ICPE-9800 Series

Energy Dispersive X-Ray Fluorescence Spectrometer
EDX-7000

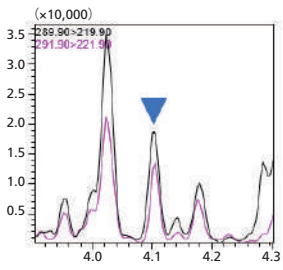


Qualitative Analysis of Ti-U in Combustion Ash

Analyzing Low PCB Concentrations in Paint/Coating Debris

Polychlorinated biphenyls (PCBs) are used as a plasticizer in some coatings. Such coatings are used to paint structural members in bridges, for example. Consequently, paint debris generated during maintenance is treated as PCB waste material. GC-MS is specified as the method for analyzing the PCB content in paint debris. While GC-MS measurements are easily affected by contaminant components, especially for PCBs with a low number of chlorines, GC-MS/MS measurements can avoid such effects and enable analysis with high sensitivity and high separation.

Gas Chromatograph Mass Spectrometers
GCMS-TQ8050 NX

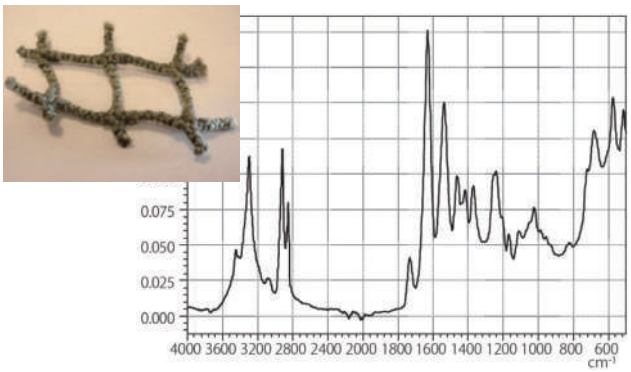


Qualitative-Quantitative Analysis of Tetra CB (#60 and 50)

Analyzing Marine Debris and Microplastics

Small plastic particles with diameters ranging from a few micrometers up to about 5 mm are referred to as microplastics. In recent years, there has been concern that such microplastics are detrimental to oceans and ecosystems. Not only the microplastic material itself, but also the additives contained in the plastic and the harmful substances that attach to the microplastics from the surrounding environment have been identified as potential causes of latent harm to humans by entering the food chain. That requires multifaceted analytical and measuring technologies.

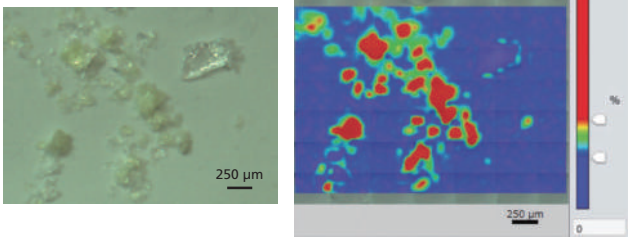
Fourier Transform Infrared Spectrophotometer
IRSpirit



Fishing Net Obtained at a Recycling Plant and FTIR Measurement Results from that Net (Identification of Polyamide)

Fourier Transform Infrared Spectrophotometer (left)
IRTracer-100

Infrared Microscope (right)
AIM-9000



Microplastics on Filter Paper (left) and Polyethylene Distribution (right)

Dynamic Particle Image Analysis System
iSpect DIA-10

Image of Particles Contained in Environmental Water

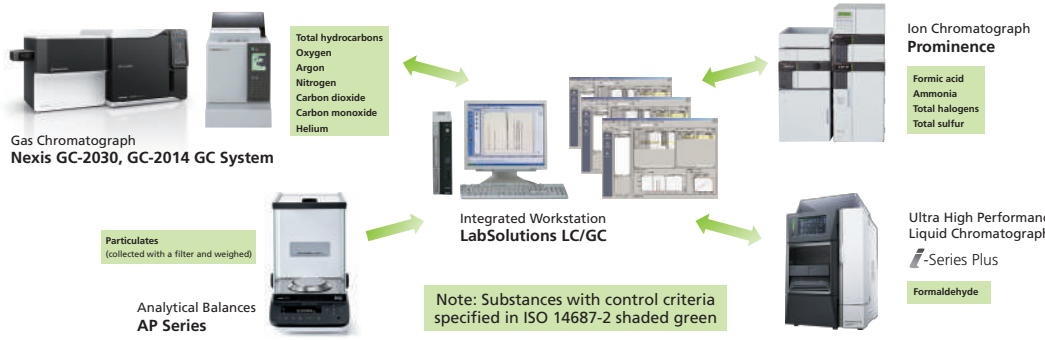
Addressing Climate Change

Renewable Energy/Environmentally-Friendly Materials

We also contribute to researching renewable energies and new environmentally-friendly materials, which are essential for the future of humankind and society. As economic growth and development progress globally, demand for energy continues to expand and there is increasing anticipation for technologies related to renewable energies for achieving a sustainable society. Shimadzu analytical and measuring instruments contribute to research and development of power generated from biofuels, biomass, or hydrogen, and to development of new environmentally-friendly materials with low environmental impact derived from nature.

Quality Control of Hydrogen Fuel

Strict purity standards (ISO 14687-2) are specified for hydrogen used in fuel cells. If the hydrogen contains carbon monoxide or sulfur components, it can break down the catalyst in the fuel cell. Shimadzu analytical instruments are useful for analysis involving in confirming compliance with the many quality control criteria specified in the standard for hydrogen fuel used in fuel cell vehicles (ISO 14687-2). Using LabSolutions LC/GC integrated workstation software enables the control and data analysis for multiple analytical instruments from a single workstation.



Quality Control of Algae Biofuels

Algal biomass is attracting interest as a new renewable energy alternative for petroleum resources. As a way of recycling CO_2, some researches on efficient fuel production by using the emitted CO_2 for the cultivation of algae are also being conducted. The quantity of biomass in culture solutions containing algae can be evaluated by using a total organic carbon (TOC) analyzer to measure the quantity of carbon in the solution. That technique is used to obtain reliable quantitative results. Similarly, cell quantities can be quickly and easily measured and evaluated using a UV microalgae analysis system. The squalene oil ($C_{30}H_{50}$) produced by the algae contains as many hydrocarbons as heavy oil, so it must be reformed with a catalyst. GC-MS systems are useful for measuring the decomposition products generated from such catalytic reactions.

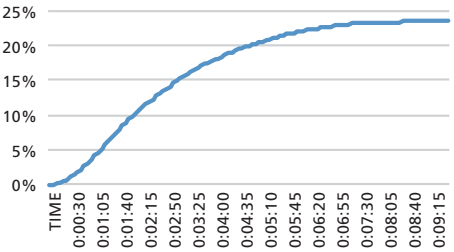
Total Organic Carbon Analyzer
TOC-L Series

Gas Chromatograph Mass Spectrometer
GCMS-QP2020 NX

Ultraviolet-Visible Spectrophotometer
UV-2600i

Measuring Moisture Content in Wood Biomass Fuel for Power Generation

For wood biomass power generation, measuring the moisture content in wood chips used as fuel is extremely important, because it is closely related to the amount of heat generated, ignitability, and combustibility. Therefore, the moisture content of wood chips must be carefully measured at the delivery point. The conventional method used involves potential sources of human error, such as drying the chips for a given period in a temperature-controlled chamber, determining the moisture content based on the weight difference before and after drying, and the manual process of recording the weights. In contrast, that complicated measurement process that previously required several hours to complete can be accomplished in only tens of minutes using a Shimadzu MOC63u electronic moisture analyzer. The moisture analyzer can also save transcribing time by sending measurement data directly to a computer, so that data can be acquired more quickly and accurately. That helps to create a more efficient working environment.

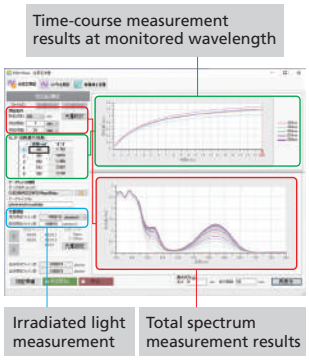


Graph of Wood Chip Moisture Content Measurement and MOC63u Electronic Moisture Analyzer

Basic Optical Technology Utilized for Artificial Photosynthesis Research

Artificial photosynthesis is technology for artificially performing photosynthesis using a photocatalyst and sunlight. It is anticipated as a next-generation renewable energy source, based on converting light energy into useful compounds. Evaluating the quantum yield (photoreaction efficiency) requires measuring the number of photons absorbed, which was conventionally measured using a chemical actinometer. The Lightway (model PQY-01) photoreaction evaluation system is a unique instrument that can quickly and accurately measure the number of photons absorbed without using a chemical actinometer.

The system was developed by Shimadzu Corporation, under the guidance of Professor Osamu Ishitani and Assistant Professor Yusuke Tamaki of the Department of Chemistry, School of Science, Tokyo Institute of Technology.

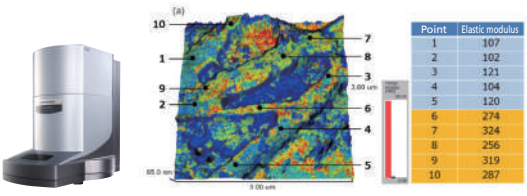


Data Analysis Software PQY™-Meas

PQY-01 Photoreaction Evaluation System
Lightway

Environmentally-Friendly Materials - Data Analysis of Cellulose Nanofibers Properties

Cellulose nanofibers (CNFs) have gained attention as a sustainable plant-based carbon-neutral material that is very environmentally compatible. CNFs must be evaluated based on fiber length, fiber thickness, dispersion, and other parameters. Nano-3D mapping functionality of a scanning probe microscope (SPM) can be used to visualize the dispersion within a composite material by overlaying an elastic modulus image on an image of the 3D shape of the CNF composite material.



SPM-9700HT Scanning Probe Microscope (left) and Elastic Modulus 3D Mapping and Measurement Results for CNF Composite Material (right)

Analytical and Measuring Instruments Offered by Shimadzu for Environmental Applications

		FTIR	·LC ·LC-MS ·LC-MS/MS	·GC ·GC-MS ·GC-MS/MS	·ICP ·ICP-MS ·AA ·EDX	IC	·UV ·RF ·Photoreaction Quantum Yield Evaluation System	·TOC ·On-Line System	·Moisture Analyzer ·Balances	·Testing Machines ·Powder Analyzers ·SPM	Thermal Analyzer
Water	Surfactants	●	●	●			●				
	Metals, heavy metals, cyanide, etc. (inorganic substances)		●		●	●	●				
	Nitrogen, phosphorus, and organic substances (eutrophication pollution)			●			●	●			
	Volatile organic compounds (VOCs)			●							
Atmosphere	Volatile organic compounds (VOCs)			●							
	NOx, CO_2, ammonia, etc.			●				●			
	Formaldehyde, benzene, etc.		●	●							
	Dust and PM2.5 (metals, ions, polycyclic aromatics, etc.)		●	●	●	●	●	●			
Soil	Benzene, dichloromethane, etc. (volatile organic substances)			●							
	Cadmium, lead, mercury, arsenic, etc. (inorganic substances and metals)				●	●	●				
	Residual pesticides		●	●							
Waste	PCB			●							
	Microplastics	●	●	●	●					●	●
Renewable Energies and New Materials	Hydrogen fuel			●		●			●		
	Biofuels	●	●	●		●		●			●
	Power generation from wood biomass								●		
	Artificial photosynthesis		●	●			●			●	
	CNF		●		●		●			●	

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SUSTAINABLE DEVELOPMENT GOALS

Introducing SDGs initiatives on our website.

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