# Preface to Special Issue "Next Generation Mobility"

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## 1. Introduction

There are many theories about the origin of wheeled vehicles, though the theory that the wheel emerged around 3,000 years BC in ancient Mesopotamia places the history of wheeled vehicles as extending over 5,000 years. Just as the need to move people and goods faster and more efficiently is present in every era of recorded history, engineers have devised improvements and inventions in every era that led to great advances in land, sea, and air transportation and support an advanced society. Our current period is called an era of mobility revolution. As well as developing mass, private, and high-speed transportation, a major focus of this period is the pressing need to protect the global environment. This period has already seen far-reaching technological progress, with rapid advances in electrification aimed at carbon neutrality, improvements in lightweight materials, autonomous driving technology for safer transportation systems, and automobiles as mobile information hubs. The mobility sector has made it its mission to offer customers new value while ensuring reliability, and delivering on this mission requires development and manufacturing across an increasingly wide range of technological fields.

This special issue of Shimadzu Review examines the entire next-generation mobility sector, not just automobiles, and takes a fresh look at the potential influence of Shimadzu's operations in this sector from the perspective of manufacturing and metrology. This special issue mainly features technically oriented articles covering topics relevant to next-generation mobility, each describing technology that can play a positive role in the mobility sector. These articles are gathered under the following categories.

## 2. Materials Processing and Testing for Electrification

This section presents technologies aimed at the rapidly growing electric vehicle (EV) sector, including a laser for processing copper materials, inspections for lithium-ion batteries, balancing machines for rotating components, and leak tests for components.

The lasers used to process pure copper materials for EVs are in growing demand, and high power blue diode lasers have the potential to meet this demand. This section describes a high power blue diode laser used to perform laser copper welding and laser copper coating. This section also describes a quality assessment of copper processing work performed using various Shimadzu analytical and measuring instruments. Lithium-ion batteries are in widespread use in EVs, and a vast array of research and development now aims to improve the power output and capacity of these batteries. This section also describes nondestructive testing that uses X-ray computed tomography (CT) to examine the internal structure of lithium-ion batteries and check for defects during the manufacturing process, with an aim to eliminate battery fires. Balancing machines are used to balance rotating components in a variety of sectors, including not only motors for mobility applications but also components for industrial equipment and home appliances. This section describes the key features of a balance measuring system equipped with an automatic balancing device designed for EV rotors. Helium leak detectors are used to perform highly accurate and high throughput leak testing on components and can obtain quantitative leak measurements regardless of the skill level of the operator. Helium leak detectors are used frequently on automated production lines that manufacture components for EVs. With helium gas being a rare resource, Shimadzu sells recovery systems to recover and reuse helium gas in leak tests, and also offers hydrogen leak test systems for leak testing with hydrogen gas, an inexpensive and readily available resource.

## 3. Innovations in Vehicle Operation

This section describes innovations related to vehicle operation, including the development of display technology and a system for the manufacture and testing of sensing

components for autonomous driving.

Head-up displays (HUDs) help improve safety in aircraft, automobiles, and other mobility platforms. This section reports on using waveguide technology to substantially reduce the size and thickness of HUD optical systems and allow for thin HUD optical systems with a wide field of view that can be installed together with a large display panel. Another area of interest is sensing components and film deposition technology for polygon mirrors and covers used in Light Detection and Ranging (LiDAR) for autonomous driving. An article describes and evaluates a high-speed sputtering deposition system creating films that exhibit good performance in wrapping around three-dimensional shapes and adhering to underlying plastic. Another article describes using a spectrophotometer and variable angle measurement unit to assess the optical characteristics (beam angle and transmittance) of cover materials for LiDAR.

## 4. Materials Testing

This section presents materials testing technology and technology used to inspect connections between dissimilar materials for applications in the mobility sector.

X-ray CT systems can be used to observe the internal structure of objects non-destructively. This section reports on a system that can capture tomographic images of objects under mechanical loading that is created by placing a small testing machine on the rotating stage of an X-ray CT device. A description of the device, examples of imaging, testing methods, and examples of collaboration with CAE analysis technology as a digital twin will be reported. In the area of joining dissimilar materials together for lighter automobiles, this section describes using an ultrasonic optical flaw detector and other measuring devices for a multifaceted evaluation of a joint between aluminum alloy and galvannealed steel sheet metal materials. Flow testers are a type of rheometer frequently used to evaluate resins. This section includes an article that introduces examples of evaluation using flow testers that contribute to the molding conditions and quality control of various plastic materials.

## 5. Communications

Shimadzu has developed an underwater data communication device that offers an online, bidirectional connection between underwater vehicles and watercrafts. The device is an underwater optical wireless device that transfers information via visible light and offers substantial speed improvements over acoustic underwater communication, which is currently the main method of underwater communication. This section describes the development of the device, key performance specifications, and future plans for the device.

## 6. Improved Efficiency

Japan's Ministry of Economy, Trade and Industry (METI) has been promoting initiatives to implement "Logistics MaaS" in the logistics industry. Shimadzu's hydraulic IoT system was used to visualize cargo handling at logistic sites in the trucking industry, revealing novel insights that may improve efficiency in transportation and delivery.

## 7. Conclusions

When you drive on a highway and see the multitude of different vehicles traveling across the country, it brings home the reality of how the movement of tangible goods and people remains an essential feature, even in today's connected society, when a constant flow of digital information is vital for everyday life. Every vehicle on that road is loaded with numerous electronic systems, lightweight materials, and safety features that typically go unnoticed. When we stop to consider the amount of technology designed into vehicles, it inspires a new respect for the engineers involved along with optimism for the future of the mobility sector, a feeling typically shared by many in the industry.

We hope this special issue inspires discussion with interested parties in a variety of fields about the direction in which the mobility sector is headed, and the role Shimadzu's technology can play in next-generation mobility.

This special issue was prepared in conjunction with the "Technology Fair for Next Generation Mobility," an online exhibition for introducing products and technologies and gathering customer feedback (MESSE SHIMADZU ONLINE EXHIBITION: Technology Fair for Next Generation Mobility, https://www.shimadzu.co.jp/messe/exhibition/mobility/, Accessed: February 20, 2023).