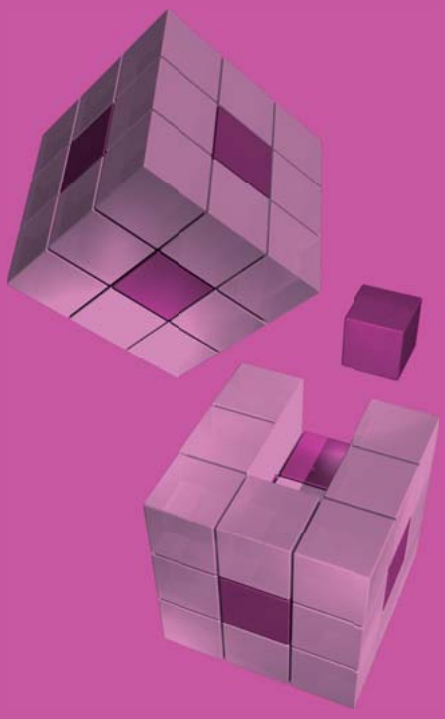


Components & Materials

Automotive Systems

■

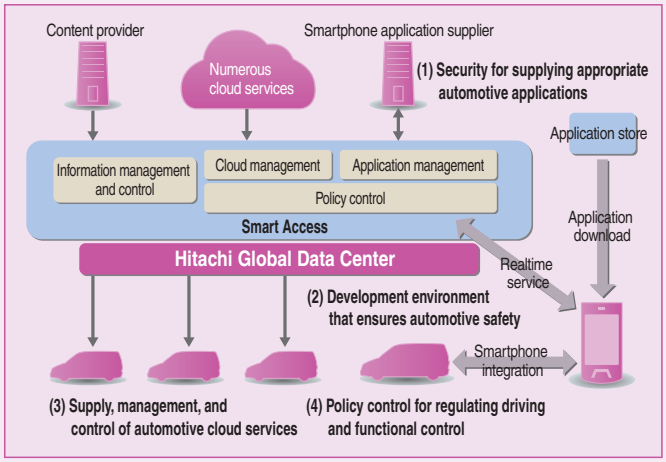
Batteries

■

Materials

Cloud Telematics Service for Realtime Information in Vehicles

Telematics systems that give access via networks to a wide range of information from on-board communications devices have now entered widespread use. Clarion Co., Ltd. has developed the Smart Access cloud telematics service that also integrates with smartphones. The service is now available in Japan and North America. The platform for the service is the Hitachi Global Data Center operated by Hitachi, Ltd. In this article, key people from the two companies describe Hitachi's current strategy for telematics and how it will look in the future.



Features of Smart Access cloud telematics service

Use of Cloud Platform for Smartphone Integration and other Smart Access Features

Recent advances in cloud computing and the widespread adoption of smartphones are having a major impact on telematics in Japan. Many functions such as map and traffic information, navigation, and music that were previously provided by on-board devices are now also used outside the vehicle. The Smart Access cloud telematics service was our solution to the challenge of delivering the functions demanded by users from around the world in this new era in a way that ensures they can also operate in a seamless and safe manner when accessed inside the vehicle.

Smart Access integrates with smartphones and cloud services around the world to supply information such as realtime traffic updates, maps, and points of interest. Users can also enjoy services such as Internet radio or social networks. As we place paramount importance on driving safety, the service can also convert this text data into speech. In other words, Smart Access has ushered in a new era in which being in a car no longer means being isolated from the outside world.

Telematics Solution Draws on Comprehensive Capabilities of Hitachi

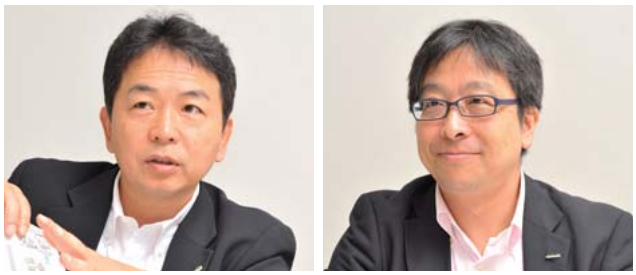
Smart Access is based around a cloud-based service to ensure that it always provides up-to-date information, with the Hitachi Global Data Center acting as the service platform.

Hitachi has since the early 2000s been working on the development of technology for the next generation of telematics, including seamless integration between on-board devices and the mobile phones, music players, and other devices that people use in their daily lives; utilization of information from the Internet; and development of the software-as-a-service (SaaS) applications that underlie these features. What made these into a real service and facilitated commercial implementation was the telematics service for the Nissan LEAF* of Nissan Motor Co., Ltd. By providing total support and operating for this service, which was launched in North America, Europe, and Japan in 2010, we acquired progressive experience and essential know-how in areas such as cloud service connectivity, application control, and the communication protocols needed for a global telematics service. Using this experience as a base, we have now developed the Smart Access service to support a wider range of users.

Expansion into Multimodal Service Domains

Infotainment (the provision of entertainment-related information) is one of the layers of telematics, and this is the initial focus of the Smart Access service. Another important layer is the "vehicle-centric" layer. We intend to strengthen this layer and work on services that ensure safe, secure, and comfortable motoring through the collection and analysis of information from on-board cameras or other sensors attached to vehicle components. In the future, our plan is to take advantage of this know-how and cloud platform to expand into multimodal service domains by integrating cloud services with all the different forms of transportation that people use to get from place to place.

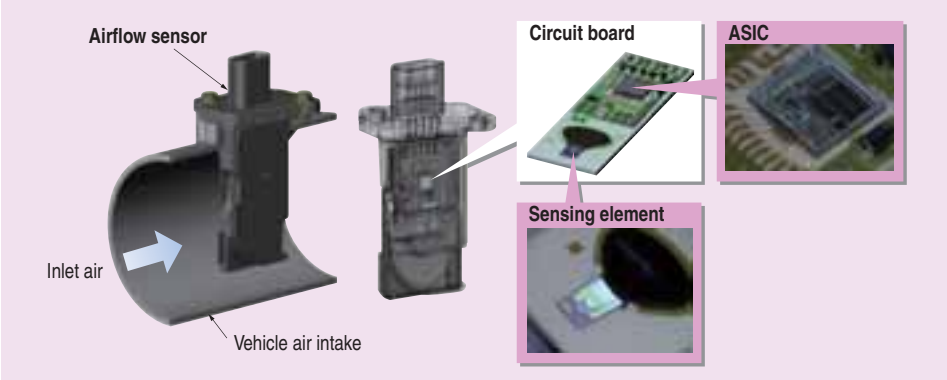
* See "Trademarks" on page 91.



Masamori Kashiyama (left), Director, Dept. 2, Car Information Systems Division, Information & Telecommunication Systems Company, Hitachi, Ltd.; Hirohisa Miyazawa, Department Manager, System Planning Department, Marketing Strategy Division, Clarion Co., Ltd.

MEMS Airflow Sensor with Fast Response

Advances such as complex valve timing control are being made in engine technology in response to recent changes, such as more stringent exhaust emission regulations and improvements in fuel efficiency. The supporting requirements for these control systems include the ability to make precise measurements even under fluctuating intake airflow conditions, with airflow sensors able to respond fast enough to deal with sudden changes (transients) in vehicle operation. The most common airflow sensors in current use are thermal sensors that utilize sensing elements formed as a region of thin film using microelectromechanical system (MEMS) technology.



Internal structure and mounting arrangement for MEMS airflow sensor in air intake

Hitachi has now developed a sensing element on a region of thin film with a thickness of approximately 2 μm that can operate heated to a temperature high enough to vaporize the oil that can be a cause of degradation due to contamination inside the engine bay. Increasing the heating temperature of the thin film region provides both a fast response and a resistance to damage by contamination in an automotive environment. To improve accuracy, Hitachi also simultaneously developed an application-specific integrated circuit (ASIC) that can perform multi-point digital tuning. In the future, Hitachi intends to further develop the sensor and improve its competitiveness by increasing the level of device integration.

(Hitachi Automotive Systems, Ltd.)

Inverter and DC/DC Converter for EV Systems for Daimler AG

Hitachi has commenced supply of integrated power electronics (IPE) for four-wheel-drive, pure-electric vehicle (EV) systems to Daimler AG (Mercedes-AMG GmbH).

The two different types of IPE supplied are, respectively, a high-power inverter and a combined unit in which this inverter is integrated with a highly efficient direct current/direct current (DC/DC) converter.

The pure-EV system consists of three inverters and one combined inverter and DC/DC converter for high performance*.

An inverter is an electrical conversion device that transforms electric power between DC and alternating current (AC) to generate the 3-phase voltage used to drive the electric motor. Similarly, a DC/DC converter converts the high voltage from the battery to the low voltage required by vehicle systems.

A special feature of this inverter is that it is the first to use a new power module developed by Hitachi. This power module uses a double-sided, direct cooling design to achieve high cooling performance.

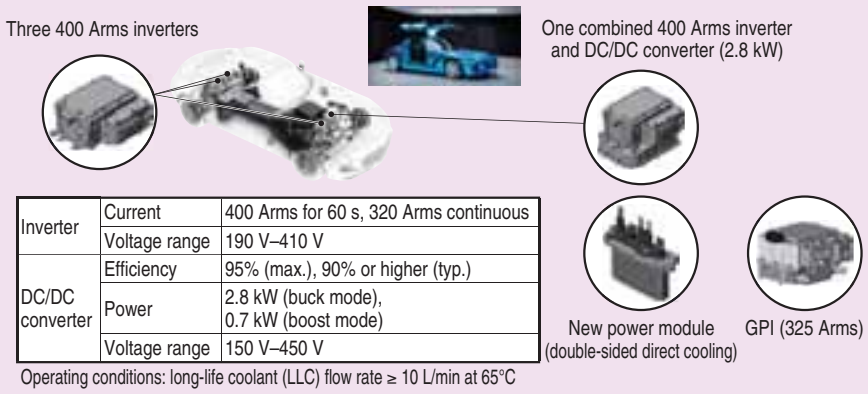
The inverter, meanwhile, uses a direct cooling design to remove the excess heat produced by electrical devices when operating at high current.

In other words, use of the new power module provides the inverter with high power and a compact design, allowing the inverters and DC/DC converter to fit into the small space available inside vehicles.

The new power module is also used in the global platform inverter (GPI) range of products.

(Hitachi Automotive Systems, Ltd.)

(Delivery start date for Daimler: April 2013)



Inverter	Current	400 Arms for 60 s, 320 Arms continuous
	Voltage range	190 V–410 V
DC/DC converter	Efficiency	95% (max.), 90% or higher (typ.)
	Power	2.8 kW (buck mode), 0.7 kW (boost mode)
	Voltage range	150 V–450 V

Operating conditions: long-life coolant (LLC) flow rate ≥ 10 L/min at 65°C

Four-wheel-drive, pure-EV system (upper), key features (lower left), and GPI (325 Arms) generation-3 inverter and new power module (lower right)

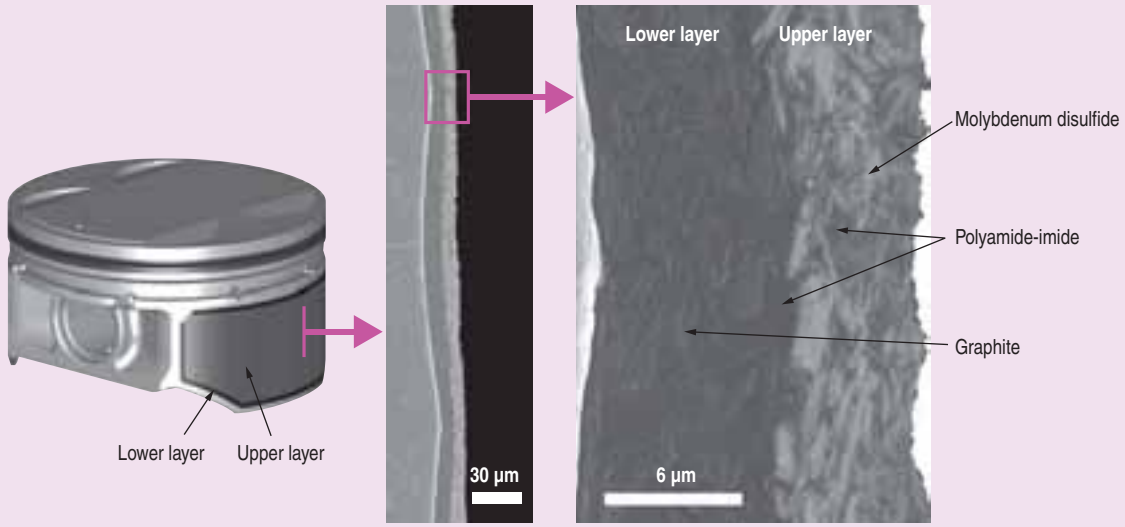
* Peak output of 392 kW and a maximum torque of 880 Nm

Low-friction Piston Technology

Hitachi has developed a solid lubrication coating for skirt surfaces that reduces the piston friction in automotive internal combustion engines. The new coating has a double-layer structure in which the upper layer wears easily and shortens the break-in time to match the material of the cylinder bore, while the lower layer has excellent adhesion strength.

The earlier wearing of the upper layer reduces friction by changing from boundary lubrication to fluid lubrication, and this was achieved through a composition that consists of 80% by mass of molybdenum disulfide (a solid lubricant) contained in a polyamide-imide resin binder. A consequence of this, however, was that the lower proportion of resin meant a lower strength of adhesion to the piston. To overcome this, Hitachi designed the coating to form as an upper layer while the lower layer maintains adhesion strength by having a higher resin content, with 30% by mass of solid lubricant (graphite).

In the future, Hitachi intends to expand the application of this technology to pistons, and to bring it up to the standard specification for solid lubrication coatings.
(Hitachi Automotive Systems, Ltd.)



Coating structure of the new coating

Semi-active Suspension for Ford Motor Company

Front strut

Rear shock absorber

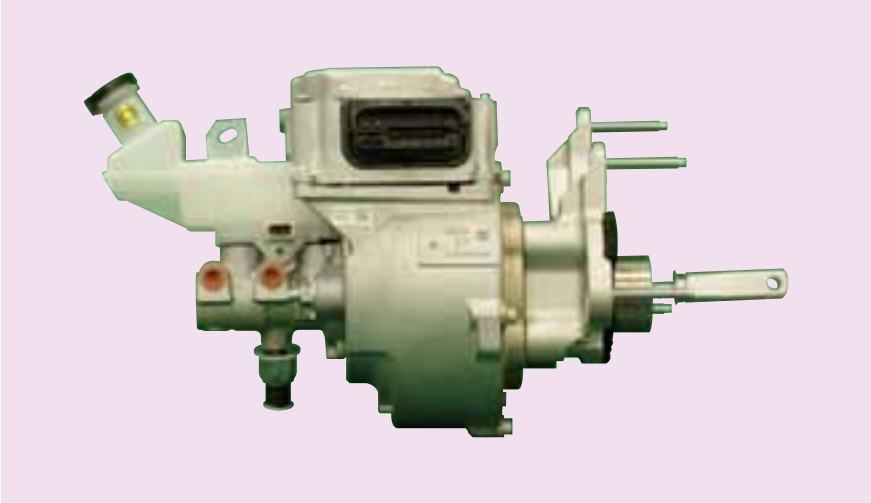
Semi-active suspension dampers for Ford Motor Company

In response to the growing demand in recent years for suspension capable of combining a high level of stability and handling with ride comfort, Hitachi has developed a damper for use with electronically controlled suspension, the use of which is becoming more widespread, particularly in luxury vehicles.

The design of the new damper uses proportional solenoids that operate Hitachi-developed damping force valves to facilitate installation and provide the quick response and wide range of variable damping force required by electronically controlled suspension. These features have seen the system adopted by Ford Motor Company for its top-end Lincoln MKS and MKZ models.

In the future, Hitachi aims to reduce costs so that the system can be used on a wider range of vehicles.
(Hitachi Automotive Systems, Ltd.)
(Commencement of full-scale production: December 2011)

Electrically-assisted Actuation Generation-2



Electrically-assisted actuation generation-2

Hitachi has developed a new electrically-assisted actuation generation-2 that is smaller and less expensive than previous models.

The system is designed for widespread use as a cooperative regenerative brake in hybrid electric vehicles and electric vehicles. Such vehicles are becoming increasingly common due to their low fuel consumption and small environmental impact.

As well as improving the cooperative regenerative function, the new product also can be integrated with a forward-looking monitor system to trigger emergency braking automatically when required.

(Hitachi Automotive Systems, Ltd.)

(Start of mass production: September, 2012)

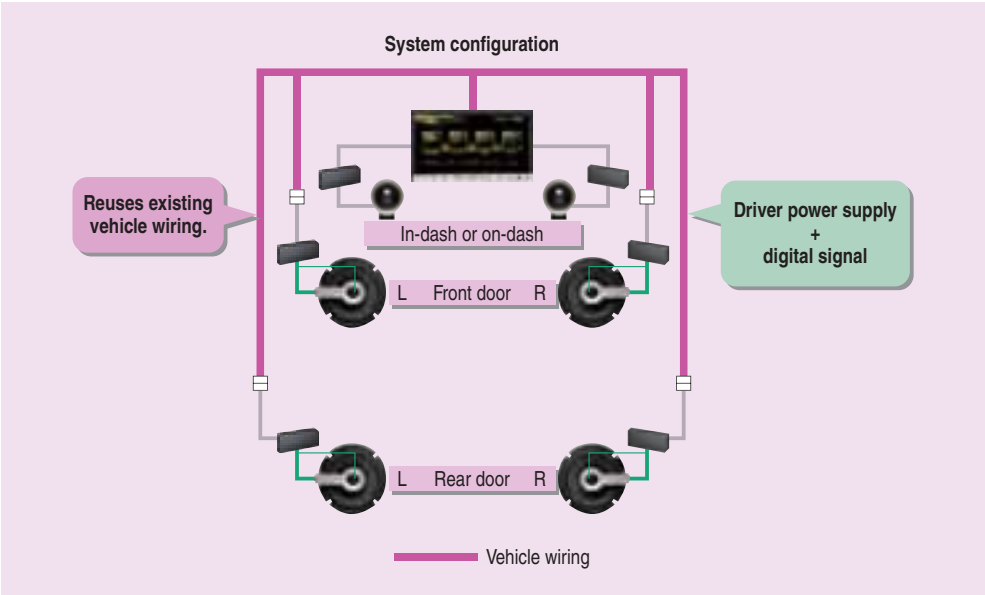
Development of System Solution for FDS Commercialization

Conventional car audio systems all connect the amplifier to the speakers using an extremely thin two-wire (positive and negative) harness that is not designed to handle the digital transmission required for full digital speaker (FDS*). Also, because an FDS requires a power supply for its associated drive circuit, providing this using existing wiring harnesses is also a prerequisite for commercialization.

The power digital line carrier system is intended to provide a high-level solution to these competing requirements. Based on low-voltage differential signaling (LVDS), it is able to carry both the digital signal and power supply over the same two harness wires by superimposing a low-power digital signal onto the power supply. As the quality of the transmitted signals is not affected by electrical noise from the vehicle power supply, it provides very high sound quality at a level beyond what can be achieved by the high-grade cabling of high-end analog systems, and does so without modifications to the existing vehicle cabling.

Having developed this technology, Hitachi is planning to incorporate it into a variety of different audio products.

(Clarion Co., Ltd.)

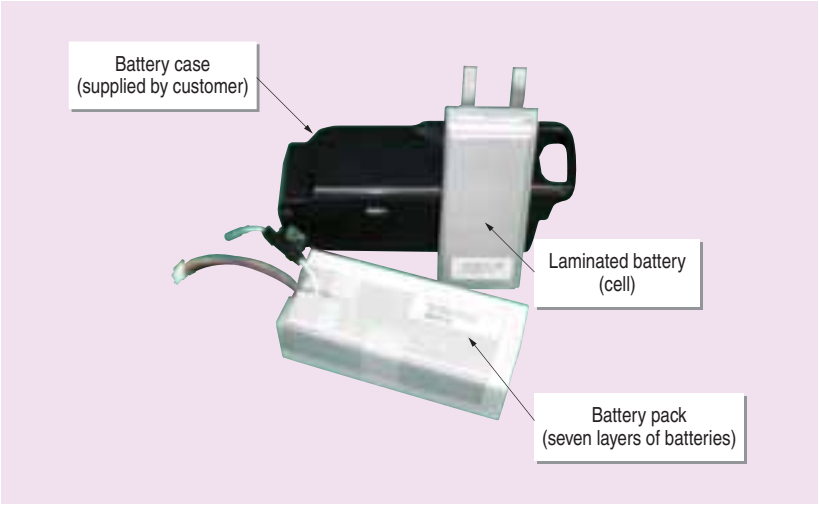


Power digital line carrier system

* A sound reproduction technique in which a digital audio signal is converted to analog and directly input to a number of speaker units or voice coils.

Lithium-ion Battery for Electric Power-assisted Bicycles

Hitachi has developed small to medium-sized (5 to 20 Ah) laminated lithium-ion batteries, and has commenced production of both batteries and battery packs for electric power-assisted bicycles made by Sunstar Engineering Inc., the first customer for these new products. Having progressively worked on the technology and commercialization of these batteries since their first application in personal computers (PCs) in 1999, the Toyama Works of Hitachi Maxell, Ltd. is now fully operational, having developed and prototyped the laminated lithium-ion batteries and installed small-scale production equipment.



Lithium-ion battery for electric power-assisted bicycles

The batteries have a rated voltage of 3.7 V and a rated capacity of 5 Ah, and use manganese cathode material with excellent safety characteristics. Each battery pack consists of seven layers of cells in serial that are installed in cases by the customer for use in the end product. Compared to the rectangular batteries currently mass produced for use in mobile phones and the cylindrical cells used in power tools, laminated lithium-ion batteries have the following features.

(1) Use of film cladding makes battery lighter.
(2) Thin shape facilitates heat dissipation.
(3) High level of flexibility in selecting battery size

In the future, Hitachi intends to proceed with a wide range of product developments, including not only bicycles and other electric vehicles or small industrial power applications, but also large static batteries and other electric power storage systems.

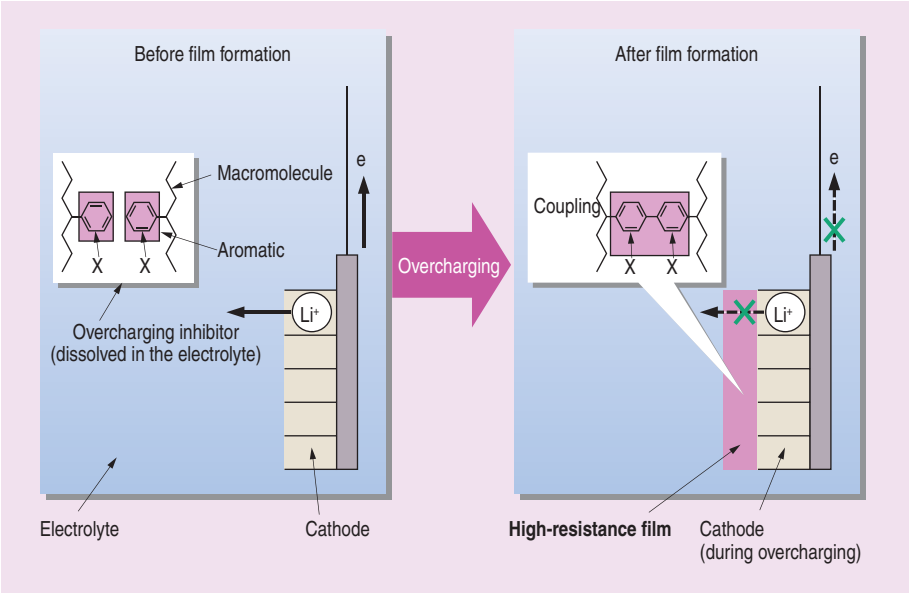
(Hitachi Maxell, Ltd.)

Overcharging Inhibitor for Lithium-ion Batteries

The increasing performance of smartphones and other portable devices is driving a requirement for lithium-ion batteries with higher capacities, and with this comes a need to develop batteries with high levels of safety. Techniques for inhibiting overcharging in particular have an important role in achieving this later objective. To satisfy these requirements, Hitachi has developed a new material that prevents overcharging.

This macromolecular material incorporates aromatic components and under normal conditions is dissolved in the electrolyte. When the potential at the cathode is high, however, the aromatic components become coupled together and precipitate as a solid, thereby inhibiting further charging by forming a high-resistance film over the cathode surface. An electrochemical analysis found that formation of the high-resistance film occurs during overcharging in the 5-V range. Overcharging tests conducted on batteries also demonstrated this ability to inhibit overcharging, and found that batteries that included the new material were immune from thermal runaway.

In the future, Hitachi intends to contribute further to enhancing the safety of lithium-ion batteries by improving life and other characteristics.

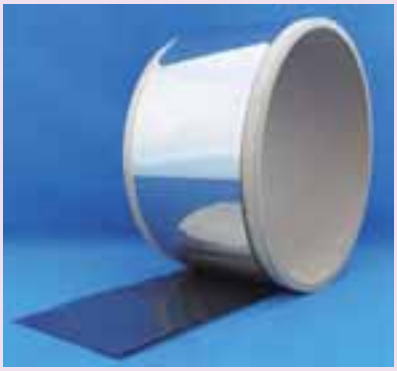


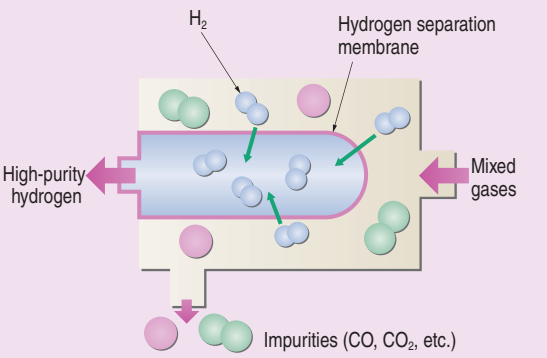
Concept of macromolecular material for inhibiting overcharging

Nb Alloy for Hydrogen Separation Membrane

Hydrogen separation membranes are recognized as essential materials for a society that utilizes hydrogen-based energy. They are special alloys that permit the selective passage of hydrogen and are used to produce hydrogen in a highly pure form. While current hydrogen separation membranes are made from expensive palladium (Pd) alloy, there is a demand for less expensive alloys to encourage greater use of hydrogen.

Recognizing the potential of niobium (Nb) alloys developed by the Kitami Institute of Technology for use in hydrogen separation membranes, Hitachi has been working on improving their properties and ease-of-manufacturing. This work has demonstrated that hydrogen permeation performance roughly equivalent to the existing Pd alloys can be achieved through adjustments to the alloy composition and the uniform refinement of the microstructure.





Nb alloy foil for hydrogen separation membrane (left) and schematic diagram showing function of hydrogen separation membrane (right)

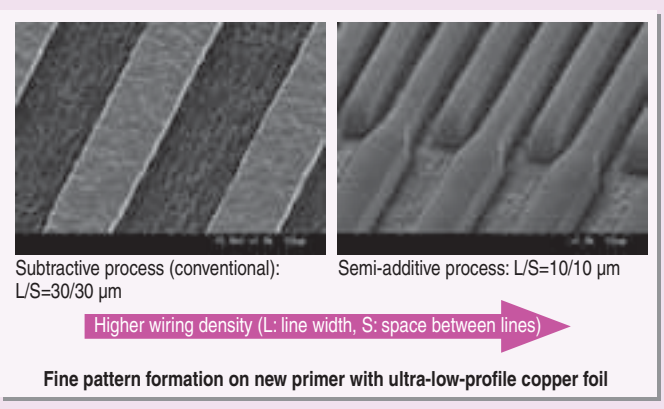
Future plans include making further improvements to material properties and investigating manufacturing processes with the aim of commencing full-scale production in 2015.
(Hitachi Metals, Ltd.)

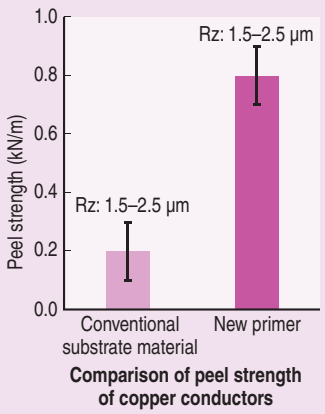
New Material for Semi-additive Process of Fine Pattern Formation on Package Substrates

The miniaturization requirements of high-performance electronic products such as smartphones and tablet personal computers (PCs) has increased demand for making electronic components smaller and thinner. A consequence of this is that high-end package substrates need to be made stiffer and capable of higher wiring densities (wiring with a pitch of less than 20 µm).

Package substrates typically consist of a core layer and build-up layers. The core layer is a glass fabric prepreg with a low coefficient of thermal expansion (CTE). The build-up layers consist of insulating film with fine conductor lines formed by a semi-additive process. The problems associated with high-end substrates composed of build-up layers include a higher CTE and a decrease in stiffness that leads to chip cracks (and mounting failure). Ensuring that the peel strength on the smooth substrate surface is sufficient for fine wiring is also a challenge.

After many studies to solve these problems, Hitachi has developed a new primer that provides sufficient adhesion for electroless copper plating and glass fabric prepreg. By combining this new primer with glass fabric prepreg, Hitachi was able to produce a build-up material able to support higher wiring densities and provide the required package substrate stiffness. This new build-up material has the potential to enhance the capabilities of the next generation of packaging.
(Hitachi Chemical Co., Ltd.)





Fine pattern formation and adhesion properties of new primer with the ultra-low-profile copper foil (kN/m)