Featured Topic: Development of Sumitomo Electric's Electric Conductor and Functional Products

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Our copper wire manufacturing technologies, which originated from Sumitomo's copper business, were subsequently applied to electrical wire and cable products. Based on these products, the Sumitomo Electric Group has continuously developed its new technologies and products.

Electrical wire and cable manufacturing technologies are divided roughly into conductor technologies and covering material technologies required for insulating wires. Let us take a look at the history of diversification of Sumitomo Electric's products along with the growth of these technologies.

This issue features some of the product groups delivered based on both sets of technologies. Figure 1 summarizes the development history of such products and technologies.

Regarding conductor technologies, in 1897, Sumitomo Copper Rolling Works, Sumitomo Electric's predecessor, opened and started manufacturing copper electrical wires. Subsequently, based on this technology, the Company developed various items, such as magnet wires, which were copper wires with varnish insulation. Other products include electric conductors for electronic components and automotive engines, combining copper wires with other metals into lamination by cladding or plating techniques, as well as aluminum electrical wires. Moreover, the plating technology led to the development of porous metals.

Meanwhile, insulation technologies delivered general-purpose resins and molded rubber parts in the early days, followed by electron beam irradiated products and fluororesin products. Moreover, fluororesin products were applied to water treatment membrane modules.

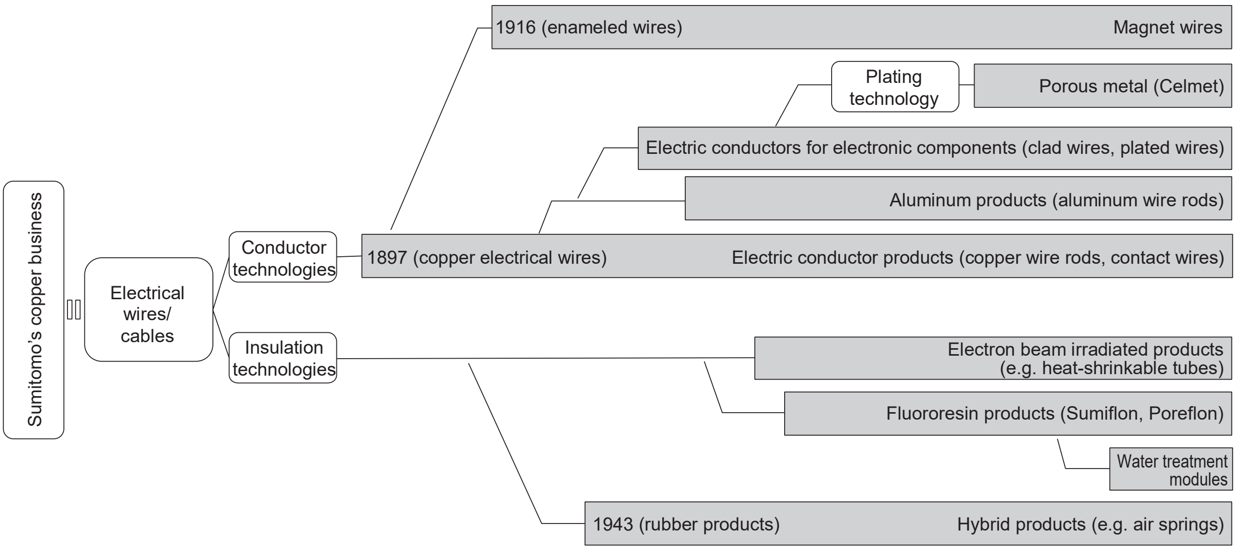

Fig. 1. Products featured in this issue

Rubber products, another lineage of insulation technologies, have evolved into air springs.

Although not shown in Fig. 1, other products evolving from electrical wires and cables include power cables, electronic wires, automotive wiring harnesses, optical fibers/cables, and flexible printed circuits. Engineering-wise, Sumitomo Electric has developed installation, transmission, control, wire-drawing, and powder metallurgy technologies. Emerged from these technologies are power cable engineering, information and communications engineering, optical transmission devices, traffic control system products, special steel wires, hard metals, and powder alloys.

This issue features the latest development of electric conductor and insulation materials that have historically served as a foundation for Sumitomo Electric's business growth. The following describes their backgrounds and an outline of the papers presented in this issue.

Development of Electric Conductor Products

In the area of electric conductor products, Sumitomo Electric has delivered highly competitive products by both developing relevant materials and polishing processing technologies. The most notable among them are rectangular magnet wires for electric-powered cars, such as electric and hybrid electric vehicles.

Conventionally, magnet wires were manufactured by forming an varnish insulation layer covering typically a round wire conductor. However, to reduce the size, weight, and cost of electric vehicles, it is unavoidable to downsize the traction motor and generator. As a relevant technique, it is effective to form the magnet wire with a rectangular cross section for a high space factor of the coil. The technique used to work a conductor into a rectangular wire is difficult. In addition, it is difficult to form a varnish layer on it. Consequently, a high level of production engineering is required to produce high-performance and high-quality products. Sumitomo Electric has attained success in the development of highly competitive rectangular magnet wires for electric-powered cars by taking advantage of its comprehensive production system from the raw materials to finished products, and promoting development through concerted efforts by the business division and R&D labs.

This issue contains a paper that reports on a development path of the rectangular magnet wire and efforts made for quality improvement.

Additionally, this issue describes the shipping of contact wires for use in the construction of a fast freight railway, an infrastructure development aid program in India. Sumitomo Electric won the order for the contact wires due to its technical expertise fostered through years of the Company's contribution to railway network construction in Japan.

Next, composite wire-making technology is reviewed as an evolved form of electric conductor processing technology.

The aim of a composite wire product is to impart properties unavailable from one material by combining two or more conductors. Composite wire products include clad wires and plated products. Clad wires combine two bulk metals as the core and outer layer, while plated products form the outer layer through plating. Combined, the resultant material has both high electrical conductivity and lightness that cannot be attained by a single discrete material. It is also possible to produce materials that exhibit two or more properties, including heat resistance, corrosion resistance, electrical discharge characteristics, and slipperiness.

This issue presents a paper on these composite wires, discussing their advantages arising from combining materials and their application examples.

This issue also features porous metals as additional application examples.

The porous metal Celmet is currently found in many hybrid electric vehicles, used as a material for the positive electrodes of nickel-metal hydride batteries. In this application, porous metal Celmet functions as a support of the cathode active material and as a current collector within the cell. This is a form of application as a novel electric conductor differing from electrical wire materials.

In recent years, expectations have been high for use of the porous metal as an electrode material for fuel cells. However, higher heat resistance is required in solid oxide fuel cells (SOFCs) than in nickel-metal hydride batteries. Moreover, in polymer electrolyte fuel cells (PEFCs), high corrosion resistance is required.

Use of Celmet in both types of fuel cells is envisioned. This issue describes a case of its use as an SOFC electrode material made possible by developing a highly heat-resistant porous metal.

Development of Products That Use Insulation Materials

As stated earlier, insulation material technologies have delivered electron beam-irradiated, fluororesin, and rubber products.

Among these products, heat-shrinkable tubes are closely related to wiring technologies.

An electrical wire is fabricated such that a conductor is covered with an insulation layer. When connecting or branching the electrical wire, the insulation layer is removed, necessitating protection, such as insulation and/or waterproofing, for the connected or branched part. Heat-shrinkable tubes are distinctive products that are retrofitted and serve these functions.

This issue reports on two-layer heat-shrinkable tubes that come with both a waterproof feature and durability to serve as a protection layer for aluminum electrical wires, which are expected to come into increasing use in line with the weight reduction of automobiles.

Additionally, regarding electron beam irradiation technology, this issue gives information on gear parts with improved fatigue strength and wear resistance, imparted by irradiating injection-molded plastic gears with electron beams. This technology is expected to contribute to the replacement of metals with plastics, adopted in the ongoing process pursued from the perspective of weight reduction.

Furthermore, products that use fluorine-based materials include the porous polytetrafluoroethylene (PTFE) film Poreflon. Poreflon is a porous material whose pore size is controlled by Sumitomo Electric's stretching technique. The product exhibits superb gas permeability and microfiltration performance attributed to the porous body, as well as heat resistance, chemical resistance, and water repellency intrinsic to fluororesin. This issue describes application examples of Poreflon to deaeration modules, which are anticipated for use as photoresists in semiconductor manufacturing processes, taking advantage of the gas permeability, and application to water treatment membrane modules utilizing the microfiltration performance.

It would be my pleasure if the readers of this issue could have an intimate overview of the dynamic history of Sumitomo Electric's technological development growing from the manufacture of copper electrical wires into diverse products.

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