Remarks on Special Issue on Solutions for Automotive Use

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It is extremely important to the Nippon Steel Corporation—a general materials manufacturer specializing in steel materials —to continue to press ahead with the development of new materials and new application technologies while recognizing the functional requirements of the industrial fields that utilize the materials the company manufactures. One such field, the automotive industry, holds an important position in our society. Our company's activity relating to development of new materials for use in automobile manufacture and new technology to form such materials has considerably influenced the environmental conditions of the automotive industry. Furthermore, in previous special issues of Shinnittetsu Giho on automobiles, the company introduced the new materials and technologies it developed for the automotive industry. Rereading these publications reminds me that the development of such materials and technologies reflected the needs of the automotive industry at the time. Below, I briefly review past development in materials and application technology, taking automotive steel sheets as an example.

In the period from the 1950s to the 1970s, during which the automotive industry underwent remarkable growth, new automotive steel sheets were developed with an emphasis on press formability, especially deep drawability, from the viewpoint of restraining the occurrence of fractures and wrinkles in the forming process and meeting the demand for elaborate design. During that period, automakers, steelmakers, and research institutes organized societies for investigating the forming of steel sheets. These societies were engaged in research into basic and key technologies relating to evaluation of materials, forming processes, and formability. On the basis of the results of such research, technology was developed to control steel chemical composition and manufacturing conditions, thereby controlling the crystallographic orientations of grains and improving the deep drawability of steel sheet. This activity eventually led to the development of steel sheets with good deep drawability in the continuous annealing process. These societies have continued to conduct research in this vein, and it is thought that such research and development of the utilization characteristics of high-strength steel sheets has helped develop new high-strength steel sheets for automobiles and new technology for forming such sheets.

Since the 1970s, in the face of energy crises on a global scale, regulations governing automotive fuel efficiency have been implemented with the aim of controlling the increase in fuel con-

sumption as a result of the ever expanding number of car owners. Under these conditions, efforts have been made to reduce the weight of cars by using thin high-strength steel sheets (mostly up to 440 MPa). Since around 1990, measures have been taken to improve the safety of cars. Initially, mainstream safety measures included application of reinforcing members or structures and introduction of the airbag. The development of various high-strength steel sheets (590 MPa or more) was advanced simultaneously, although use of these steels did not become widespread immediately. Since the second half of the 1990s, regulations regarding CO_2 emissions and fuel efficiency have become increasingly stringent in response to the global warming issue. In order to cope with such restrictions, the automotive industry has made strenuous efforts to reduce the weight of car bodies and improve the efficiency of engines/driving systems. In addition, the industry has brought more and more hybrid cars and electric vehicles to market.

Needless to say, employing thin high-strength steel sheets is effective from the viewpoint of reducing the weight of car bodies. Recently, the proportion of high-strength steel sheets has come to exceed 50 weight percent of all steel used in certain models of cars. The current trend toward lighter weight cars will continue in the future. World Auto Steel has implemented the Next-Generation Steel Car Body Program. There, the application of high-strength steel sheets was discussed in earnest with the recognition that reducing the weight of car bodies is important even if existing driving systems are revolutionized in future.

It is a well-known fact that the formability (the ductility, in particular) of steel sheet decreases as its strength is increased. Then, fractures and wrinkles tend to occur easily during forming of the sheet. The springback phenomenon is also a major problem, preventing the desired product shape from being obtained during the forming process. Therefore, future development of forming technology should focus on solving the above problems and making it possible to form products of any desired shape. To that end, it is important to develop not only materials with superior formability but also forming technology that allows for the optimum use of high-strength steel sheets. Various new technologies are being developed for the improvement of characteristics such as crashworthiness and weldability, since these characteristics are important for the effective utilization of high-strength steel sheets.

Two special issues of Shinnittetsu Giho have been published previously, in 1994 and 2003, on steel materials for automobiles. The 1994 issue reported the development of various types of high-strength steel sheet and the properties of new materials, including forging steels, high-strength gear steels, steel tubes, high-strength steel wires for steel cord, stainless steel foil for metal support, resins, and aluminum. The 2003 issue reported the development of new high-strength steel sheets and the properties of steel sheet for hot stamping, various types of bar steel, various types of surface-treated steel sheet for general use, high-strength steel wires for steel cord, and stainless steels for exhaust systems (reflecting the demand for exhaust system components with higher heat resistance and corrosion resistance). This issue also reported the advantageous features of electrical steel sheets for traction motors of hybrid cars and electric vehicles, and titanium materials light in weight and high in strength. Furthermore, the above special issue reported both the materials and related application technology.

As mentioned above, compared to mild steel sheets, high-strength steel sheets are more sus-

ceptible to fractures and wrinkles because of their mechanical characteristics, making formation of products with the desired shape difficult. Therefore, when applying high-strength steel sheet to automobiles, it is important for the steelmaker to share recognition of the above issues with the manufacturers of automobiles and parts. In particular, it is important for the steelmaker to develop both superior steel materials and technology for the effective application of these materials; this is why the 2003 special issue contained a report on relevant application technologies.

This special issue places greater emphasis on application technology for various types of new materials for automobiles than the 2003 issue. Application technology has developed markedly, particularly the use of high-strength steel sheets. Therefore, this special issues reports the followings developments in application technology: a) forming technology, including shape defect correction/stretch flange fracture evaluation and prevention utilizing computer simulations, and new forming techniques (hydroforming, hot stamping, and sheet forging); and b) technology relating to crashworthiness, including techniques to evaluate the deformation behavior of structural members during a crash. For effective utilization of steel sheet, it is extremely important that welding of sheets is performed properly. To that end, it is particularly important to solve the problems inherent in high-strength steel sheets. The results of recent developments in the practice of welding are also reported in this special issue. Effective utilization of aluminum—a promising material applicable in the reduction of car body weights—requires it to be welded with steel sheet. The recent development of technologies for joining aluminum and steel sheet is also described in this special issue.

Furthermore, this special issue reports the current state of development of materials, including ultrahigh-strength steel sheet, warm forming of aluminum alloy, steel sheet for fuel tanks, and electrical steel sheets for traction motors of hybrid cars and electric vehicles.

The development of technology for application to bar steels and wire rods has also advanced considerably. Many special steel bars are formed by hot or cold forging. Technology for forging analysis and prediction of the properties of hot- or cold-forged parts and steel materials with superior cold forgeability have also been developed; these developments, too, are described in this special issue. The application technology for steel cord for tire is reported with respect to wire rods. In addition, in light of the recent advent of high-function tires, the stranded cord structure that has become increasingly diversified and complicated has been studied with the aid of CAE.

Nippon Steel Corporation, a materials manufacturer, considers it necessary not only to supply materials but also to propose methods of utilizing them effectively. Therefore, the company proposes various application and evaluation techniques in addition to developing new materials. Needless to say, it is the varied knowledge and demand obtained from cooperation with customers that make the above activities of the company possible. Cooperation with universities and research institutes is also important in this respect. Utilizing basic and key technologies obtained from, for example, universities, we will continue developing advanced new technologies. The company is aiming to become the leading steelmaker in the world and is looking forward to the continued guidance and cooperation of all persons concerned.