
Introduction

THE GLOBAL AUTOMOTIVE INDUSTRY is driven by consumer preferences, government regulations, and competitive pressures. Environmental, governmental, and customer demands to reduce fuel consumption, improve driver safety, ensure product reliability, and increase affordability have prompted the auto industry and material suppliers to develop a wide range of solutions to meet these requirements. The solutions include: optimization of product design, incorporation of lightweight materials, utilization of downgaging, and application of innovative manufacturing processes. All these solutions are interconnected and depend on the properties and attributes of the lightweight material.

New high-strength steel grades with superior attributes have been developed to compete with other lightweight materials on the basis of cost, performance, and manufacturability. At the core of this development is the advanced high-strength steel (AHSS) family, in which microstructures are manipulated to produce impressive mechanical properties such as very high tensile strength and remarkable ductility. Advanced high-strength steels are not intrinsically lighter than other steels, but they are strong enough that thinner gages can be used to reduce vehicle weight. Steel remains the dominant engineering alloy for building cars and structures because of its affordability, performance, manufacturability, recyclability, and wide range of applications. The typical 2010 light vehicle uses approximately 1080 kg (2390 lb) of steel. The versatility of steel results from its vast combinations of constituents, phases, microstructures, and thermal histories. These permutations impart to the steel properties that are desired for many applications. Also, the presence of the steel infrastructure and the knowledge acquired to manufacture steel products make it the material of choice for tomorrow's transportation products. Many auto manufacturers have aligned themselves with a lightweight strategy that is based on increasing AHSS content in their vehicles. Using AHSS presents manufacturing challenges in springback, die wear, press tonnage,

and welding that must be resolved before any large-scale adoption of these materials is realized.

1.1 Drivers and Solutions

To ensure long-term success, automakers' business models, strategies, and activities have always been based on three major drivers:

- Consumer demands for lower cost, high quality, better performance, good reliability, higher safety, advanced features, and improved fuel economy
- Government regulations on Corporate Average Fuel Economy (CAFE) standards, crash safety, and gas emissions
- Competitive pressures on cost, quality, performance, and manufacturability

The automotive industry has identified four solutions to address these industry drivers and meet their business goals:

- Optimize product design
- Reduce vehicle weight
- Use low-cost materials
- Employ innovative manufacturing processes

All four solutions are based on the selection of lightweight materials that meet performance and cost requirements. The automotive industry, material producers, and part suppliers have been working for years to develop and deploy ferrous and nonferrous lightweight materials. It has been demonstrated that AHSS are the most affordable and best performing materials for lightweight applications. They can be used to reduce structural component weight by using thinner sections while maintaining the same performance characteristics. This “downgaging” leads to lighter vehicles and reduced costs.

One of the major environmental and societal challenges for the 21st century is the global increase in urban pollution—which results from the growing demand for petroleum consumption—and its adverse effect on the global climate. The estimated number of automobiles in the world will exceed 1.12 billion by 2015. According to the International Organization of Motor Vehicle Manufacturers (OICA), the world auto production for 2011 reached over 80 million vehicles. Over the next five years, the projected number of global vehicles produced annually will exceed 100 million. In 2011, the share for North America, which includes the United States, Canada, and Mexico, amounted to approximately 13 million vehicles. Of that annual production, the U.S. share is approximately 8.6 million units. Figure 1.1 shows historical and projected North American light