AIST's executive director Ronald E. Ashburn: Strength, formability, recyclability, cost make AHSS practical lightweighting solution for carmakers.

The new AHSS steel was not in your father's Oldsmobile

Earlier this year, General Motors introduced a redesigned version of the GMC Acadia, its popular midsized crossover SUV. The vehicle has a number of new safety and fuel efficiency features, such as stop-start technology that shuts the engine down when the driver brakes and turns it on when the driver accelerates. But from our perspective, the most notable thing about the redesign is what GM left out – 700 pounds of weight.

The new Acadia is 15 percent lighter than the 2016 model, a reduction engineers were able to achieve partly through simple design – it's now 7.2 inches shorter and 3.5 inches narrower. But they also incorporated press-hardened, advanced high-strength steels into the body structure. That allowed certain structural parts to be made from thinner steel, which, in turn, reduced its curb weight. And even with thinner components, safety performance was maintained, or even improved, over conventional materials, which we believe is the ultimate testimonial for deploying advanced steels.

This is but one example of how advanced high-strength steels are helping automakers create lighter, and not to mention, safer, cars and trucks, a primary strategy in their effort to meet increasing fuel economy standards mandated by the federal government. The standards are ambitious, and they've been the catalyst for some clever engineering, not only in how automakers design their vehicles, but in the materials they're utilizing in the manufacturing process.

To meet weight-reduction targets, some are relying heavily on aluminum alloys, most notably Ford and its aluminum-bodied F-150 pickup. Others have adopted a mixed-materials approach, such as BMW and its 7-series, which uses a mix of carbon fiber, aluminum and steel to reduce weight and improve driving characteristics.

Indeed, automakers these days have a menu of materials to choose from – advanced steels, aluminum, magnesium alloys, carbon fiber composites, a wide variety of plastics and resins, and structural adhesives, among them. But all materials are not equal, and in addition to lightweighting considerations, there are a variety of factors to consider when choosing which to use. And cost is at the top of the list.

Additionally, engineers must consider a material's ability to be stylistically shaped and the ease with which it can be joined or welded to a dissimilar material. They also have to take into account the degree to which collision damage can be affordably repaired, or even repaired at all. End-of-life recyclability is yet another consideration.

Considering all of those -- cost, energy intensity, ease of manufacture, maintenance, safety and environmental protection -- advanced steels offer automakers the best all-around light-weighting solution.

But looking at advanced steels strictly as a lightweight material, it offers plenty of potential. In fact, engineers could cut the weight of a typical sedan by as much as 23 percent if they were to use only commercially available high-strength steel in place of mild steel. If they were to incorporate advanced grades soon to be entering the market, the reduction could be even greater, as much as 26 percent, according to estimates from ArcelorMittal's S-in motion program, which encompasses its lightweight automotive steels.

As ArcelorMittal USA chief executive John Brett said during AISTech 2016, our annual conference and exposition, "(Steel) can lightweight with the best of them."

Automakers seem to agree with John, considering that AHSS is the fastest growing automotive material, according to market researcher Ducker International. The firm forecasts the average amount of advanced steel in North American light vehicles to rise to nearly a quarter-ton by 2025, about double the amount used in 2014.

According to Larry Kavanagh, president of the Steel Market Development Institute, the increasing interest in advanced steels arises from the fact that its light-weighting capabilities are continuing to exceed expectations and offers design solutions that are free of the major manufacturing cost penalties associated with other materials.

And even though advanced steels have been around for several years, we're only beginning to unlock their light-weighting potential.

Case in point: the U.S. Automotive Materials Partnership, in conjunction with four steelmakers, five universities and a national laboratory, last year developed one of the first steels with true third-generation, advanced high-strength properties: steel that is exceptionally strong, yet incredibly ductile.

This particular steel has a tensile strength of about 1,200 megapascals, which means that it can withstand 174,000 pounds of force per square inch before failing. By comparison, mild steel typically begins to fail at around 250 megapascals of force.

At the same time, this third-generation steel will stretch, or elongate, to more than 30 percent of its initial length before it breaks. That's important for automakers because they need steel that can bent and pressed into unique aerodynamic shapes without cracking or breaking.

Separately, another company called NanoSteel has created an advanced sheet steel that, as it claims, has a tensile strength of 1,200 megapascals and ductility of 50 percent, as measured by elongation.

The company, which is partnering with AK Steel on the project, delivered the product to GM for testing and acceptance this spring, and chief executive David Paratore has said he believes the company is ready to begin making it commercially.

"We went through all the ups and downs that come with taking a new material from the lab to commercial scale, but we're over those hurdles now," he said recently.

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As with all advanced technologies, there are challenges to overcome. Despite more than 150 years of industrial production, we have so much more to learn about the atomic-level structures that give rise to steel characteristics. What's most exciting is that we are making sophisticated advances every day. This headway can be seen in the U.S. Automotive Materials Partnership project, which also created a model for predicting the advanced, high-strength characteristics that will arise based on the steelmaking recipe. This model will advance the development of third-generation grades and make the process more efficient for steelmakers, leading to quicker rollouts of new applications and products.

Aside from creating stronger, lighter steels, the industry must continue to advance production efficiency for these grades. The need for research and development is ever more apparent as these advanced grades are technically challenging and time consuming to make, and, as it is, many of the North American mills are designed for high-volume production.

AHSS production can pose a serious strain on mill production, and the challenges in making the advanced grades carry through the entire steelmaking process.

The new grades call for high-purity iron, and so scrap-based producers will need to enhance refinement capabilities, as many already have. In casting, stronger steels could be prone to cracking, and so continuous casting equipment may have to be updated in order to cope with the issue. In rolling, some of the new grades require special force and temperature control to obtain the desired properties.

The industry is – and has been -- responding to demand for these steels with significant capital investments. Perhaps the largest current investment comes from startup Big River Steel, which is building a $1.3 billion mill in Arkansas designed to make advanced grades but while operating with the flexibility of an electric arc furnace producer.

Elsewhere, AK Steel is building a $36 million research and development center to aid in its efforts. It also is investing $29 million to modify the hot-dipped galvanizing line at its Dearborn Works in Michigan, allowing it to turn out both coated and cold-rolled AHSS.

In Alabama, AM/NS Calvert, the ArcelorMittal-Nippon Steel joint venture facility, is investing $100 million in capability upgrades. The project includes new batch annealing facility improvements and upgrades to the continuous annealing and hot dipped galvanizing lines and inspection facilities.

In 2013, Pro-Tec, an Ohio-based joint venture between United States Steel Corp. and Kobe Steel, commissioned a $400 million continuous annealing line. The line, built to serve auto customers looking for lightweighting options, is capable of annually producing 500,000 tons of advanced steels.

Nucor Corp. also has made significant capital investments to serve the auto markets, spending nearly $100 million to equip its Berkeley, South Carolina, mill to produce wider and thinner high-strength steels. And in June, the company announced a joint venture with Japan's JFE Steel Corp. to build a $270 million galvanizing mill in Mexico to serve the automotive markets.

To be sure, the steel industry is arming itself in the battle to acquire automotive market share. This lucrative market is ultracompetitive, and so it will take time and significant investment to make additional inroads. But the steel industry is more galvanized than ever in its fight against competing materials for the auto industry. As an industry veteran of 30 years, I sense that steel is rising to the occasion unlike never before.

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