



DOE SBIR/STTR SUCCESS

When subjected to high impact forces, automotive “crush cans” made of 1500MPa Flash® Steel absorb energy like an accordion, making vehicles safer during crashes.

FLASH STEELWORKS, INC.

A long-standing goal for the U.S. Departments of Energy (DOE) and Defense (DOD) has been to replace the steel in civil and military vehicles with a lighter-weight material that performs better in case of crash and under ballistic attack. Research has shown that a 10% reduction in vehicle weight increases fuel economy from 6% to 8%. To date, efforts to replace steel with aluminum, titanium, magnesium, or carbon composites have not been successful because these materials are from 3 to 30 times more expensive than steel. In addition, their use would involve a complete retooling of vehicle factories, requiring billions of dollars in investment. Flash Steelworks, Inc., formerly known as SFP Works, LLC, is about to turn the dream of lighter, stronger vehicles into reality with an innovation that is brilliant in its simplicity.

FACTS

PHASE III SUCCESS

After only one DOE SBIR Phase II award, Flash Steelworks, Inc. has received a \$1.3M Phase III from DOE's Advanced Manufacturing Office and attracted the interest of numerous Fortune 500 Companies.

IMPACT

1500 MPa Flash Processed Steel can remove 10-20% of a vehicle's weight. This will result in a lifetime fuel savings of 170 gallons/car or 2.5 billion gallons of fuel for the 17 million cars sold each year in the US.

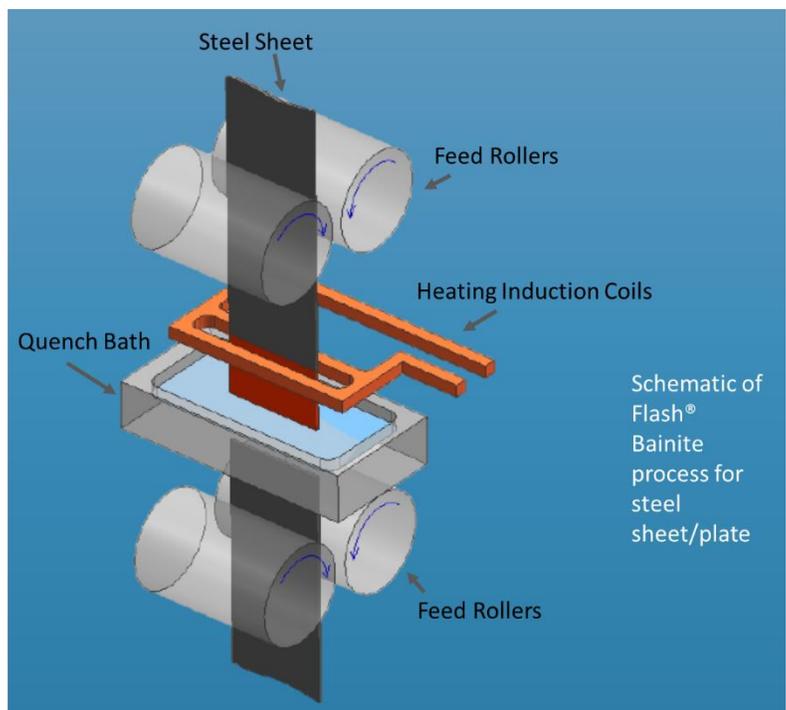
DOE PROGRAM/OFFICE

Energy Efficiency and Renewable Energy (EERE)/Advanced Manufacturing Office (AMO).

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Instead of turning away from steel, Flash® inventors have just changed the processing of normal, off the shelf steel, and in so doing they have dramatically changed common steel's microstructure and physical properties. Flash® Technology is different than the complex alloying experiments previously tried by others, which have resulted in steels that are non-weldable, brittle, and too costly for automotive applications. Flash's new process consists of an inexpensive and rapid heat treatment, which preserves the natural heterogeneity of the steel and results in a highly complex, multi-phase, multi-chemistry material. A steel strip is fed continuously through an induction heating coil, and subsequently through a quench bath in order to heat the steel to over 1000 °C and immediately cool it to room temperature in less than 10 seconds (see schematic below). Such a simple, inexpensive, and fast process converts the lowest cost, commercially available steel into the world's strongest, cold stampable steel. For their work, the Flash® team has been recognized as the 2017 DOE's SBIR Small Business of the Year.

The steels used today in the automotive industry are referred to as Advanced High-Strength Steels (AHSS) and are themselves engineered materials with carefully selected chemical compositions and microstructures resulting from lengthy controlled heating and cooling processes. Current AHSS that is formable in a stamping press has tensile strength levels between 1000 and 1200 MPa. By comparison Flash® Steel has demonstrated a tensile strength of 1600 MPa to 2000 MPa. Flash® Steel is stronger than Ti alloys (such as Ti-6Al-4V) at only 56% of the volume and 10% of the cost. The combination of much higher tensile strength and increased formability of



Flash® Steel as compared to typical AHSS steel, allows engineers to design vehicles made from parts that are lighter, yet stronger than existing parts made with AHSS.

Simultaneously, the costs of Flash® Steel production equipment and the processing times are significantly less than the currently used solutions. This makes a sound business case for the commercialization of Flash® Steel. High-performing prototype components were tested in five Automotive Original Equipment Manufacturers (OEMs) and demonstrated a mass reduction of 25-50%. These results were obtained during a single DOE SBIR award, which started in 2014 with a Phase I and is currently in Phase IIB. In 2017, the Flash was awarded a \$1.3M Phase III contract from the DOE Advanced Manufacturing Office (AMO) directed by Robert Ivester (DOE, Energy Efficiency & Renewable Energy, EERE). The Phase III project, managed by David Forrest (DOE, AMO) will prove Flash Steelwork's Flash Processing concept at full-scale, employing 20,000 pound coils of steel.

The Phase III work is proceeding on schedule and the Flash® Production Line is expected to be operational at the end of 2018. This Flash Line will cost \$1.3M and will be capable of producing 15,000 tons of Flash® Steel per year. The cost with this annual production capacity is projected to be \$100/ton. In comparison to current steel processing equipment at \$300-500M cost, the Flash® Production Line offers a much lower threshold, which will allow numerous companies to participate and expand the commercialization of Flash® Steels. Moreover, since Flash® Processing requires less than 10 seconds, the Flash® Process itself will offer significant energy savings over current heat treatment processes. As a consequence, a variety of companies have shown keen interest in the outcome of the Flash® Line project, which reduces the risk for follow on investment by the private sector. Flash® Steels are predicted to offer higher performance at significant cost and mass savings—a win-win for automakers.

In addition, Flash® Processing is also being employed to produce Ultra Hard Armor (UHA) for military applications. Flash® UHA was certified by the U.S. Army Research Laboratory for full scale production on November 13, 2017. While the U.S. Army strongly discourages welding the few competing grades of UHA, Flash® UHA is readily weldable at room temperature. Such unparalleled weldability will allow armored vehicles to have 15% higher protection or 15% part mass reduction for increased mission mobility. As expanding the footprint of SBIR technology is highly desired, deriving Flash® UHA from the Flash® automotive knowledge base is yet another example of the Flash® long term potential.

Gary Cola, Founder and CTO of Flash Steelworks, Inc. recognizes the importance of having received a DOE SBIR award. “The SBIR program was the most important aspect of our progress besides the Flash® technology itself” Mr. Cola explained. “Receiving the financial assistance from the Phase I SBIR helped us break free from Independent Research and Development (IRAD) testing and led us into the Auto OEM test labs. The simple fact that people heard we received a Phase I SBIR made industry take Flash® more seriously.” Mr. Cola added. Receiving the Phase II was financially instrumental in prototyping many automotive components and validating that steels from around the world could all be Flash® processed. Having a globally deployable technology that could function with locally produced steel, as validated by the Phase II, demonstrated the versatility and worldwide potential of Flash®. Finally, having received a Phase III encouraged highly respected equipment builders to seek Flash® out to participate in the equipment build. Internationally known and highly respected equipment companies built the Flash® Phase III coil-to-coil processing line for very fair pricing to be on the leading edge of what DOE considers a high-potential technology.

In addition, Flash’s five SBIR projects are a good example of how DOE SBIR companies and DOE National Laboratories can collaborate to increase private sector commercialization of innovations derived from Federal R&D, thereby increasing the Nation’s economic growth. During Phase II, the Flash team was given the opportunity of collaborating with scientist at Oak Ridge National Laboratory (ORNL), which is home to the Manufacturing Demonstration Facility (MDF), DOE’s first research facility established to aid the adoption of additive manufacturing (AM) and composite technologies within U.S. small-, medium-, and large-scale industries for clean energy applications. In Mr. Cola’s own words, “the facilities and expertise provided by the MDF and the research group of Prof. Sudarsanam Suresh Babu were essential to understand the underlying microscopic mechanism that makes Flash® Steel work so well.” Once DOE’s

AMO realized the potential of Flash Technology, the Office provided ORNL \$500K of direct funding to investigate Flash® beyond the scope of the SBIR award.

Flash Steelworks, Inc. is currently working to further understand important aspects of Flash® sheet steel and its impact on production tooling. Such information, and the development of new techniques for increasing stamping tool life, will be of great benefit to the Auto Industry in achieving their long term goal of lighter, stronger, safer, and less costly vehicles.

Written By Claudia Cantoni, Commercialization Program Manager, DOE SBIR/STTR, October 2018.