Flash® Processed Steel for Automotive Applications

DE-SC011857 - Phase II

Project Period: August 2015 – July 2017

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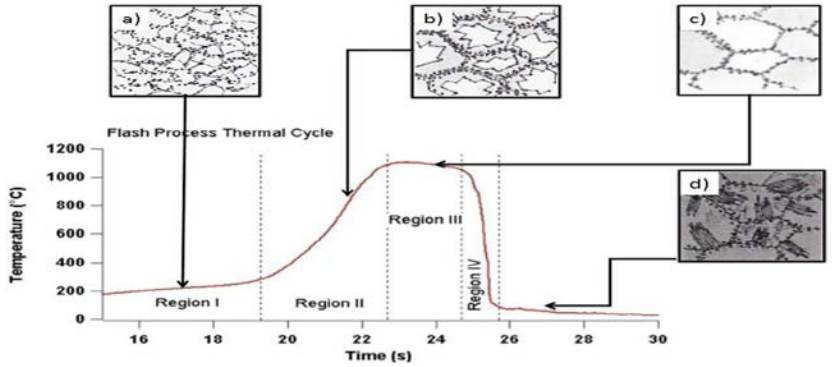
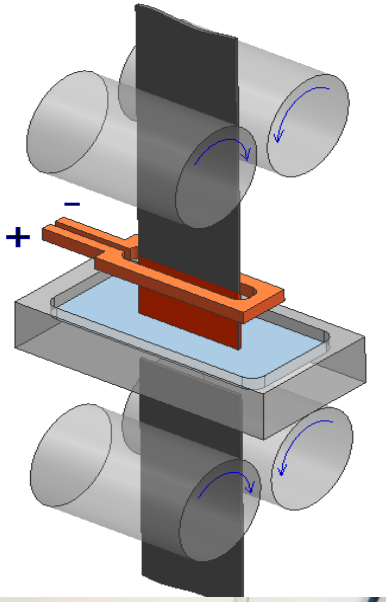
Project Objective

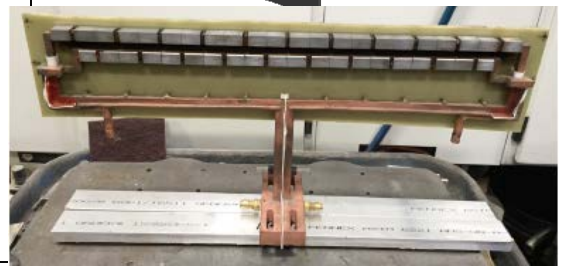
- Create a process for making Advanced High Strength Steel (AHSS) that
  - Uses plain carbon (AISI 1020) steel as a feedstock
  - Has a tensile strength of 1500 MPa or higher
  - Has the necessary formability to be cold stampable
  - Is readily weldable
  - Represents a > 30% weight savings to OEMs compared to other AHSS like DP1000.
  - Represents a > 40% per part material cost savings to OEMs compared to cold-forming DP1000.
  - Represents a > 50% per part cost savings to OEMs compared to hot-stamping 1500MPa steel.
  - *Is readily recycle-able without contaminants like 3-5%wt manganese*
- This task is difficult because after decades of research by 10,000 metallurgists around the world, no steel technology previously existed to produce steel that meets this criteria.

Technical Approach





a) In Region I, the steel is preheated to about 200 °C due to thermal convection in the steel.
b) In Region II, the rapid increase to a temperature of over 1000 °C promotes the formation of austenite, which increases the ability of the material to absorb carbon in the crystal structure.
c) In Region III, austenite forms with multiple carbon concentrations present in grain sizes from 5 to 7 microns.
d) In Region IV, the rapid, controlled cooling rate limits carbon diffusion from the crystal structure and leads to the formation of a complex heterogeneous mixture of low carbon ductile bainite and high carbon strong martensite.



Flash Processing leverages the inherent heterogeneity in steel to develop an engineered micro segregation of phase and chemistry by limiting carbon migration and carbide dissolution. Multiple organizations have analyzed Flash.

- Two Masters theses from The Ohio State University, guided by Dr Suresh Babu (now at Oak Ridge National Lab/Univ of Tennessee – Knoxville) fully rationalized the transformation mechanism of Flash Bainite. Weldability was studied in conjunction with Edison Welding Institute.
- US Army ARDEC, Aberdeen Test Center, and Army Research Labs predicted a simultaneous cost and weight savings with simultaneous enhanced performance.
- UTK – Knoxville and Oak Ridge National Lab have studies underway to review global deployment of Flash

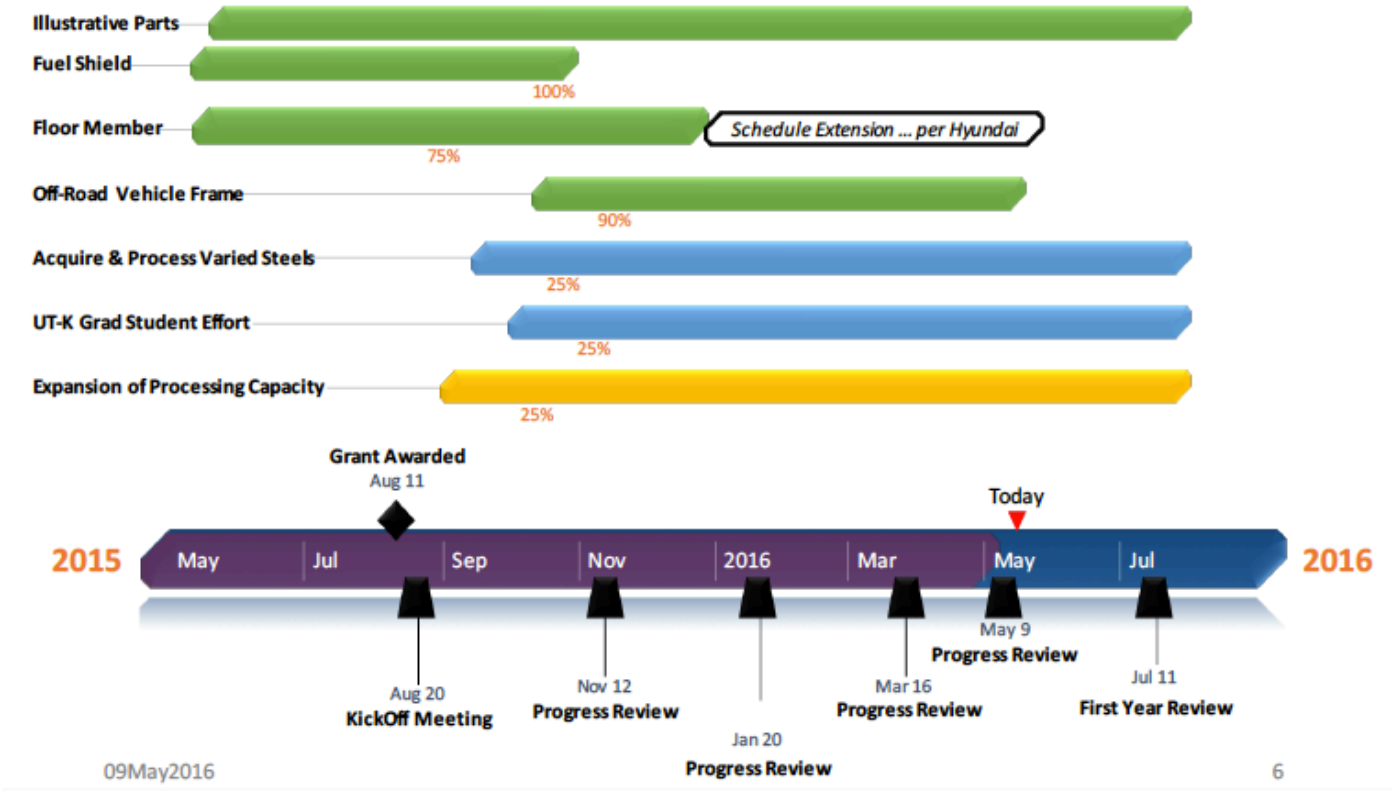
Transition and Deployment

- The end goal is to use Flash Process AHSS to make cars that are safer, lighter, and more fuel efficient.
- The end user of Flash Processing technology is the Auto OEM. In daily driving, the vehicle's owner will benefit from reduced fuel consumption.
- Commercialization will occur via Pilot Line development ultimately resulting in OEM/Tier 1 adoption/licensing of the technology at the manufacturing center itself.
- Contrary to the past 8 years, multiple globally recognized Steel Mills are currently evaluating Flash.

Measure of Success

- Project success will result in cold stamped sheet metal components such as B-pillars, roof rails, floor reinforcements, and seating components being made 25-58% lighter, readily weldable, and with 25-50% less material cost from globally sourced input steel.
- Flash technology, once commercialized will allow 10's to 100's of pounds of weight savings with similar cost savings to Auto OEMs *per vehicle*.
- The lifetime embodied energy savings for a given model year of 16 million cars sold in the US using Flash Processed steel would exceed 1.04 Quad. As Flash steel penetrates multiple model years, this translates to a savings of 9B gallons of gasoline worth $27B annually to consumers.

Project Management & Budget



- The 24 month, $1M Phase II SBIR is >45% complete and on schedule.
- The stated goals are being met and the Flash team is regularly complimented for ”over delivering”.
- Year 2 work is readily achievable with “extras” planned.

Results and Accomplishments

- The Flash Bainite for Automotive Applications Phase II SBIR is 45% complete. Flash Bainite sheet metal has been formed into numerous automotive components "cold stamped" at >1500MPa and a partial "monster truck" frame.
  - Review of domestically sourced AISI1020 has found that 9 heats of steel from 5 US Mills leads to Flash 1500 that is indistinguishable from each other regardless of input source. Global input steel is inbound.
  - Fuel shields, B-pillars, floor reinforcements, roof rails and seating components have been cold stamped at 1600MPa offering a 25-58% mass reduction and 25-50% cost savings.
  - Three Auto OEMs have been found exceptional results in impact testing. Three other OEMs are starting IRAD tests.
  - Three OEMs want to know "when" coils of Flash will be fully commercialized and available for their use in vehicles. Discussion underway with 3 Steel Mills and 2 Service Centers.
  - ***Flash "Stainless Steel" has tested at 1800MPa and 12% elongation gaining interest from the largest Oil/Gas Producers. Automotive Fuel Systems and Armor applications exist as well.***