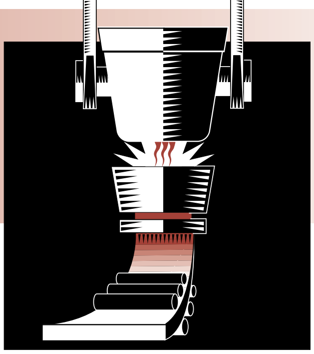
STEEL

Project Fact Sheet



New Ultra-Low Carbon High-Strength Steels with Improved Bake Hardenability for Enhanced Stretched Formability and Dent Resistance

Benefits

- Cost reduction through energy savings from improved yield
- Estimated 10 percent improvement in yield
- Annual estimated energy savings of 34.4 trillion Btu per year at full implementation
- Reduced CO_2, NO_X and SO_2 emissions

Applications

The technology has the potential for application to the production of about 15 million tons of steel per year used for critical applications.

Research related to the improvement of bake hardenability will result in energy and material savings in the steel plant and in the automotive industry

Paint bake-hardening is essentially the strain aging increment found after forming and aging for 20 minutes at 180°C. It is commonly assumed in the steel industry that the carbon and nitrogen in solution in the ferrite at the time of paint bake hardening is responsible for the bake hardening strengthening increment observed. However, numerous studies have that there is little correlation between the interstitial solute level and the measured paint bake hardening hardening response. The goal of achieving a large and consistent paint bake hardening is impossible at this time due to lack of a basic understanding of the paint hardening mechanism.

The University of Pittsburgh, working with its partners in the steel industry, universities, and National Laboratories propose to maximize the paint bake hardening increment in ultra-low carbon high-strength steel sheets in a consistent and reproducible manner. The program will apply and build on the substantial efforts and capabilities of team members in the understanding of material behavior and processing, the characterization of microstructure and formabillity specific mechanical properties, and the computer modeling of dent and crash resistance. The successful completion of this program will result in large energy savings for steel plants and in the transportation sector. The development of a bake-hardening steel with elevated and consistent properties would translate into material and energy savings for two reasons. First, a more consistent steel would lead to fewer rejects and a reduced need for remelting and reprocessing. Second, a smaller amount of higher strength steel would be required per automobile because of gage reduction, leading to fuel savings. Full scale implementation of the results of the proposed research will lead to energy savings in excess of 34 trillion British thermal units (Btu) by the year 2025 in the steel industry alone.

Improved Bake Hardenability

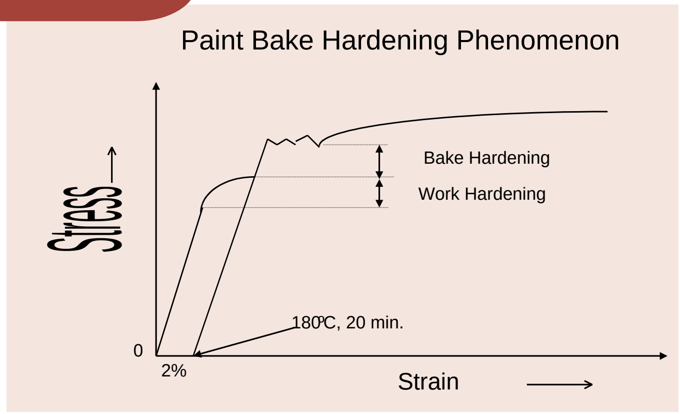


Diagram of the paint bake hardening phenomenon.

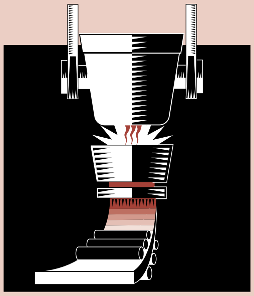
Project Description

Goal: To maximize the paint bake hardening increment in ultra-low carbon high-strength steel sheets in a consistent and reproducible manner and to obtain cost savings in steel plants from improved product yield. The performance target would be to introduce a consistent 65 percent increase in yield strength, i.e., from 150 MPa as received to 250 MPa following the heat-treatment, while maintaining good formability. This will be accomplished by gaining insights into the mechanisms of flow stress increment, as well as specific factors and processing conditions that influence strain aging via the dislocation content and its overall mobility. Computational tools will be employed to model the improved dent resistance of the optimally bake-hardened steels.

Progress and Milestones

Specifially, the program will include the following tasks:

- Project start date, May 2001.
- Characterize the as-received microstructure, texture, interstitial content, and mechanical response to develop a consistent baseline of properties for further improvement, February 2002.
- Determine material properties for optimum formabiblity under unaxial, plane-strain, and biaxial loading states, May 2002.
- Develop a criteria for bake-hardening based on on a fundamental understanding of the interaction between the strain path, strain state, interstitial character and content, and the bake-hardening time-temperature response, January 2003.
- Develop an ultra-low carbon high-strength steel that can provide a consistent bake-hardening increment of 100 MPa, while retaining good formability, November 2003.
- Predict and validate the strength dependent improvement in impact and dent resistance of the bake-hardened steels via computational tools, March 2004.
- Project completion date, May 2004.



Project Partners

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