

# 9944 Improved Criteria for Acceptable Yield Point Elongation of Surface Critical Steels

## Benefits

- ❖ Yield improvement by reduction of rejects.
- ❖ Move toward common measurements and specifications for YPE

## Applications

Exposed automotive steel panels.

Yield point elongation (YPE) is considered undesirable for surface-critical applications where the steel is formed, since “strain lines” or Luders bands are created during forming. Thus, steel manufacturers usually aim for zero YPE in these applications, tailoring their alloy and process design strategies and operating practices accordingly. In practice, a small amount of YPE (e.g. a few tenths of 1%) is usually considered acceptable, although there are no clear or uniform acceptance criteria, and decisions are usually made on a local basis by manufacturers, substantially influenced by commercial issues, and without clear technical guidance.

The subject of Luders band formation and propagation was researched extensively in the past, but has received little attention in the past 20 years or so, and is thus deserving of reinvestigation within a current industrial context and using modern instrumental techniques.

## Stretcher Strains in Low Carbon Steel

Example: Bottom of Aerosol Paint Can



**Project Goal:** The project has the following primary objectives:

- (1) to characterize the geometry of Luders bands that occur during forming of steels having yield point elongation (YPE) and
- (2) evaluate and modify acceptance criteria for steels under “modern” application requirements.

The Luders phenomenon has a great influence on the perceived product quality in many applications. Relevant studies on the subject are mostly decades old and reevaluation of YPE acceptance criteria is appropriate using modern instrumentation within the current application context including metallic and organic coating systems.

Preliminary results obtained recently with a non-contact optical surface profilometer suggest that Luders bands may be less severe than previously thought, and are in fact shallower than surface imperfections that were “hidden” by a modern automotive paint system evaluated in a recent AISI/DOE study. Extension of this preliminary work forms the basis of this project, with objectives to examine in more detail the formation of Luders bands in industrially relevant strain states, to examine the influence of starting (substrate property) conditions, and to better understand the influence of galvanized/galvannealed coatings on Luders appearance.

### **Progress and Milestones**

- ❖ Project start date: December 2004
- ❖ Obtain test materials: May 2005
- ❖ Initial data generation: December 2005
- ❖ Measurement and analysis of test matrix materials: October 2006
- ❖ Project completion date: December 2006

**Total Project Cost**      \$210,306

**Duration** 2 years

### **Research Organization**

Colorado School of Mines  
Advanced Steel Process &  
Products Research Center  
Golden, CO

### **Industry Participants**

Dofasco Inc.  
Hamilton, ON, Canada

SeverStal  
Dearborn, MI

Stelco Inc.  
Hamilton, ON, Canada

U.S. Steel - Posco  
Pittsburg, CA

U.S. Steel  
Pittsburgh, PA

### **For additional information, Please Contact:**

#### **Colorado School of Mines**

Dr. John Speer  
jspeer@mines.edu

#### **American Iron and Steel Institute**

BV Lakshminarayana  
blakshmi@steel.org