USER STORY

Using Electron Microscopy to Develop a Green Environment Through Light Weight Vehicles

This is a collaborative work between the **McMaster Steel Research Centre** and **Stelco Inc.** as part of the NSERC/Stelco Industrial Research Chair in Advanced Coated Steels.

The Problem: Vehicle efficiency is strongly linked to vehicle weight. Advanced steels allow significant weight reductions through the use of thinner gauge sections, but the surfaces are not compatible with conventional zinc coating processes which provide outstanding, cost effective corrosion protection.

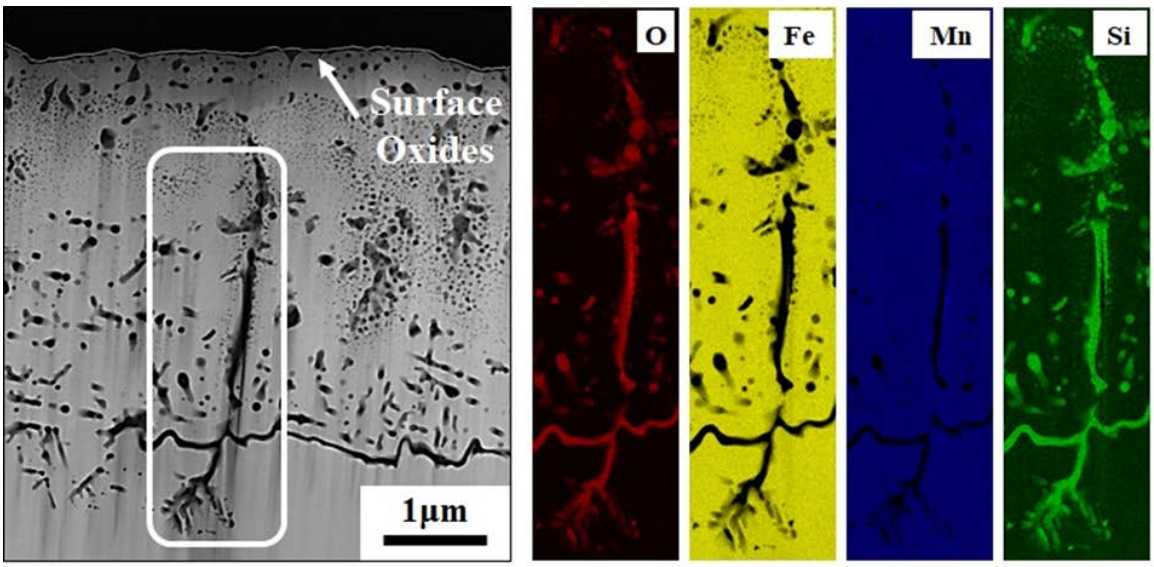
The Solution: Design advanced steel surfaces which are compatible with the conventional galvanizing process such that they can be successfully deployed in automotive structures and have long-term anti-corrosion stability.

- Scanning electron microscopy (SEM) with secondary electrons was used to examine the distribution of oxides on the surface of the steels.
- Scanning transmission electron microscopy (STEM) and electron energy loss spectroscopy (EELS) were used to create elemental maps and examine the location of oxides with respect to the steel surface.
- EELS spectra were used to identify the surface and subsurface oxides through fine structure analysis of the O-K, Mn-$L_{2,3}$ and Si-K edges.
- Focused ion beam (FIB) trench cuts were used to examine the thickness of the surface oxides and the depth of subsurface oxides on/in the steels to determine the oxidation kinetics.
- Atom probe tomography (APT) was used to show Sn segregation to the surface of the steel samples such that the oxide structures were optimized.

> “Different complimentary techniques were required for my project based on the various scales of examination. Having all of the needed techniques in one location was necessary and resulted in my use of the CCEM.”
>
> *Ghazal Seyed Mousavi, Ph.D. Candidate*
> *McMaster University 2018*

The Results:

- **Optimized advanced steel surfaces**: Manufactured steel to maintain mechanical properties while reducing overall materials mass and providing robust corrosion protection. This resulted in increased lifetime and quality of steel coatings and the lifetime of the steel automotive body.
- Decreased corrosion by providing integral Zn-based coatings on the steel surface.
- This leads to cars that are lighter, while lasting longer and maintaining passenger safety. We can manufacture cars that can decrease greenhouse gas emissions, helping in our fight against climate change.



STEM cross-sectional micrograph of high strength steel, along with the EELS elemental maps of the area shown within the region of interest.

Instruments Used:

- SEM JEOL JSM-7000F
- FEI Titan 80-300 HB
- Ziess Nvision
- Cameca LEAP 4000X HR

References:

G. S. Mousavi, J. R. McDermid, Surface and Coatings Technology, 351, 2018, pp. 11-20.

G. S. Mousavi, J. R. McDermid, Metallurgical and Materials Transactions A, 49A,2018, pp. 5546-5560.