GREAT DESIGNS IN STEEL

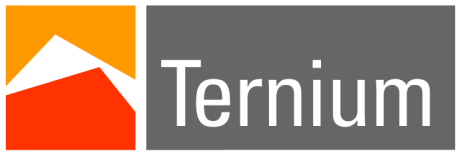
STAMPING TOOLING OPTIMIZATION
STO P# 10.2: DIE WEAR TESTING – PHASE II
3RD GEN 1180 GI & EG MATERIAL

J.P. Singh
General Motors
Global Stamping - Technical Integration Engineer (Steel)

2023

Auto/Steel Partnership

Members



PROJECT TEAM MEMBERS

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Project Leader: D.J. Zhou, Stellantis

Project Manager: Michael White, A/SP

Project Team Members:

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- Patrick Ricchi, General Motors
- Paul Wolcott, General Motors
- Peter Clifton, General Motors
- Scott Holden, General Motors
- Shawn Schaffert, General Motors
- Dean Kanelos, Nucor
- Arnie Newsome, Nucor
- Jiwoong Ha, Posco America
- Philippa Chiu, Stellantis

PROJECT GOALS

- Project Goals:
  - To obtain new knowledge by comparing/calibration test results with die wear simulated sliding energy calculations
  - Relationship of die wear to sliding energy density of 3rd Gen AHSS stampings

- Project Objective / Problem Statement:
  - Utilize the newly developed die wear sliding tabletop tester to do a series of experimental test on 3rd Gen AHSS of GI and EG coated sheet steels in order to help improve forming die material, surface treatments, lubricant and coating

  - Lack of understanding of the behaviors of sliding wear of 3rd Gen AHSS sheet steels with GI and EG coatings with forming die surface of various materials, surface treatments, lubricant and coating

PROJECT APPROACH

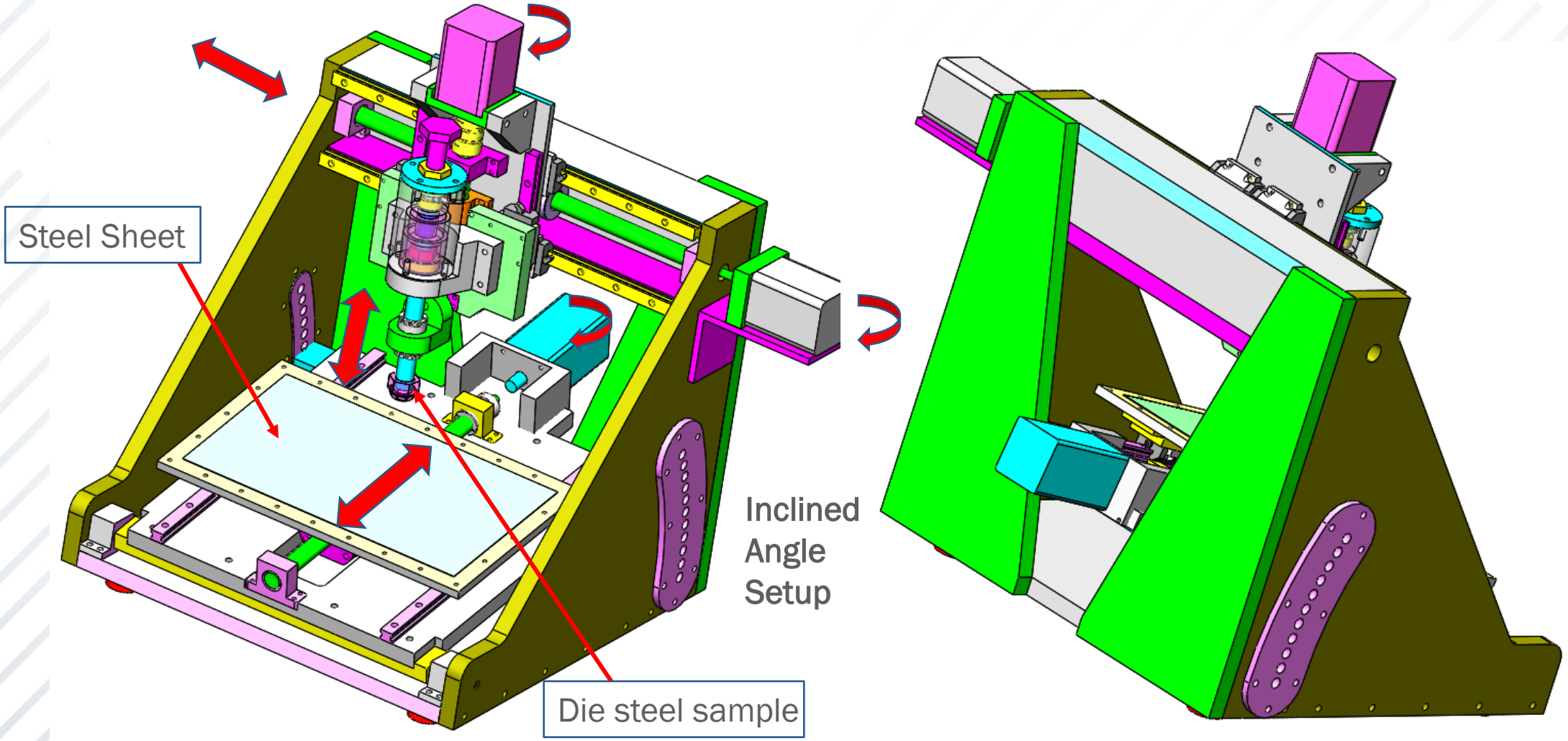
- Perform the following tasks by conducting a series of friction/wear test as follows:
  - Run the test for each case with ASP provided pin and lube
  - Examine (optical) any wear and/or surface build-up on the pin
  - Examine (optical) any damage on either the sheet and/or the pin
  - Collect friction data and evaluate integrated sliding energy for each test case

- Participants:
  - University of Windsor (Prof Nie and team - principal investigator and conduct testing)
  - Microfixtures (build and machine die wear pins)
  - Sun Steel (heat treater)
  - Ionbond (coater)

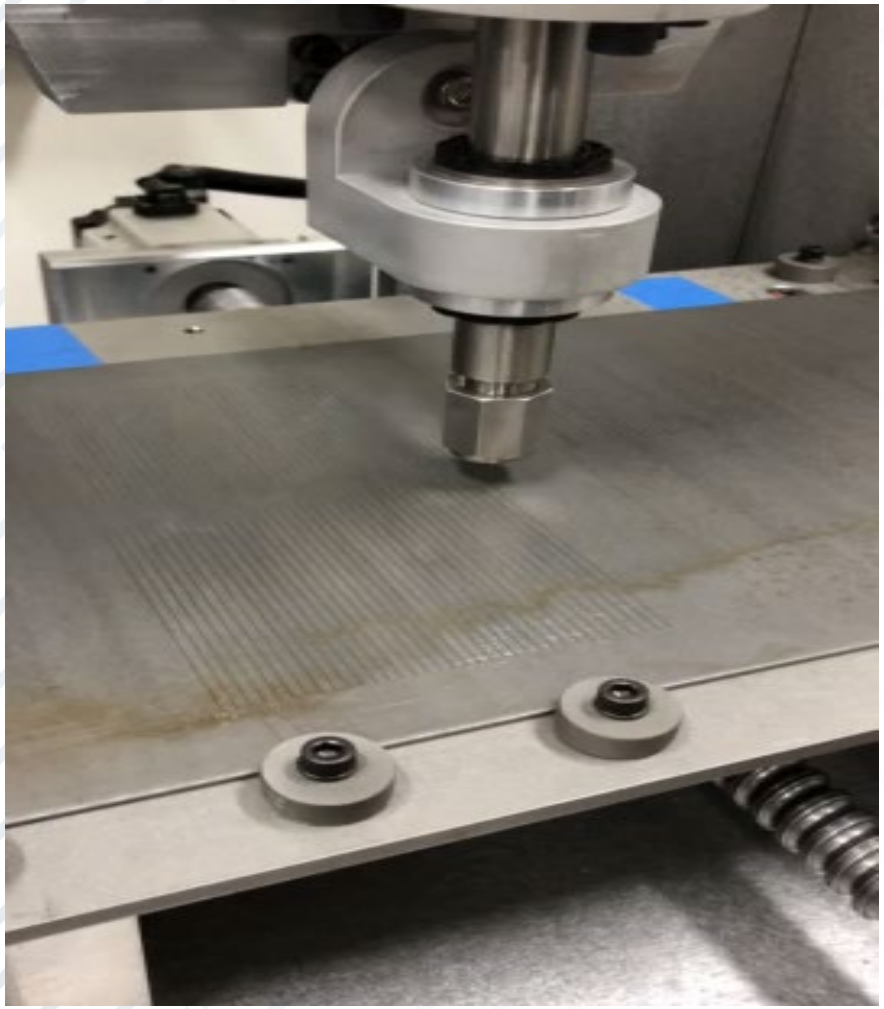
SLIDING TABLE TOP TESTER

Front Isometric View

Back Isometric View



SLIDING WEAR TEST



DEMO

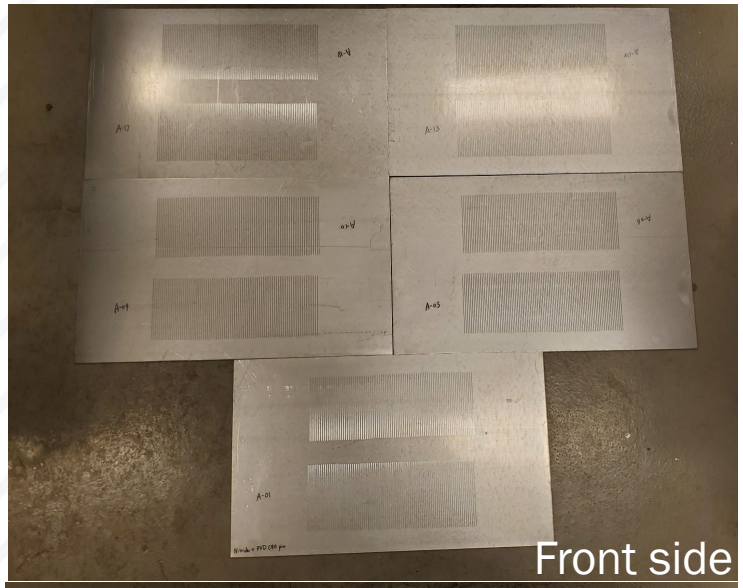
Force: 200N
Wear Track Length: 100mm
Speed: 100mm/s,
Line Spacing: 3mm

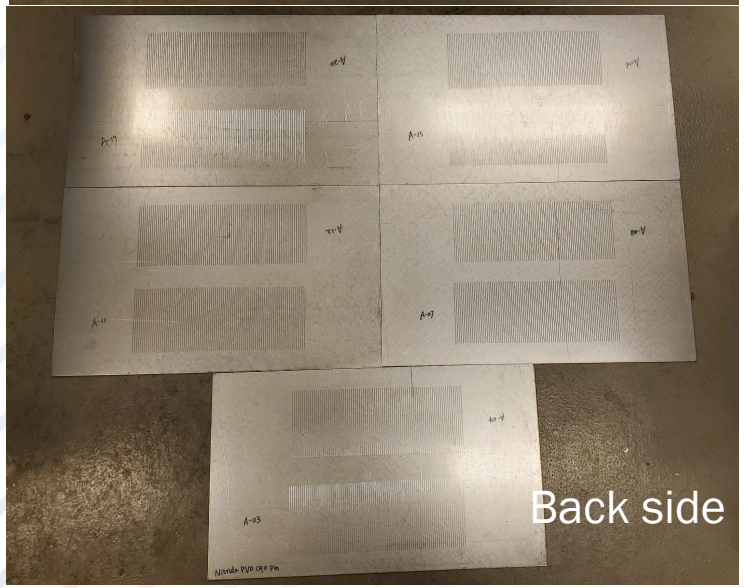
P#10.2 related:

Sheet Materials: CR1000Y1180T-RA-SE-GI, CR850Y1180T-DP-EG
Tool material: Caldie Steel Ball, Hardened HRC 60, 15mm dia
Tool heat treatment/coating; Nitriding; Nitriding+PVD C90

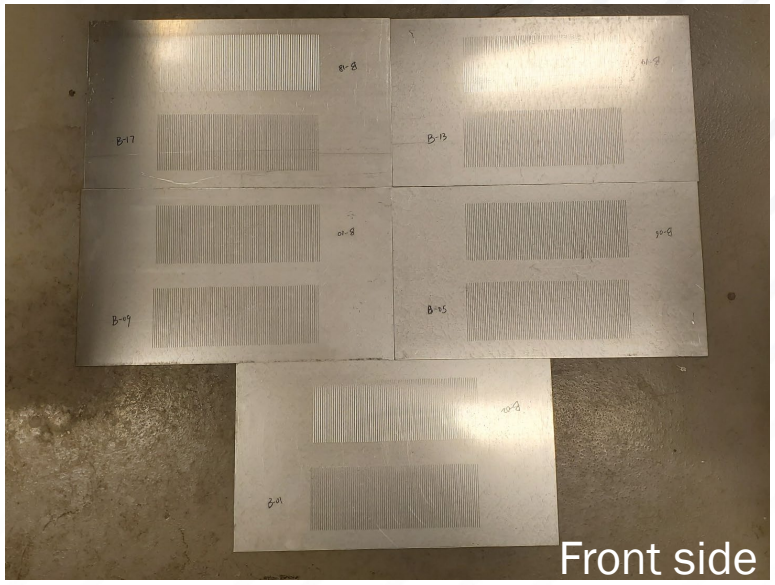
PROJECT RESULTS (WEAR TESTED SHEET SAMPLES)

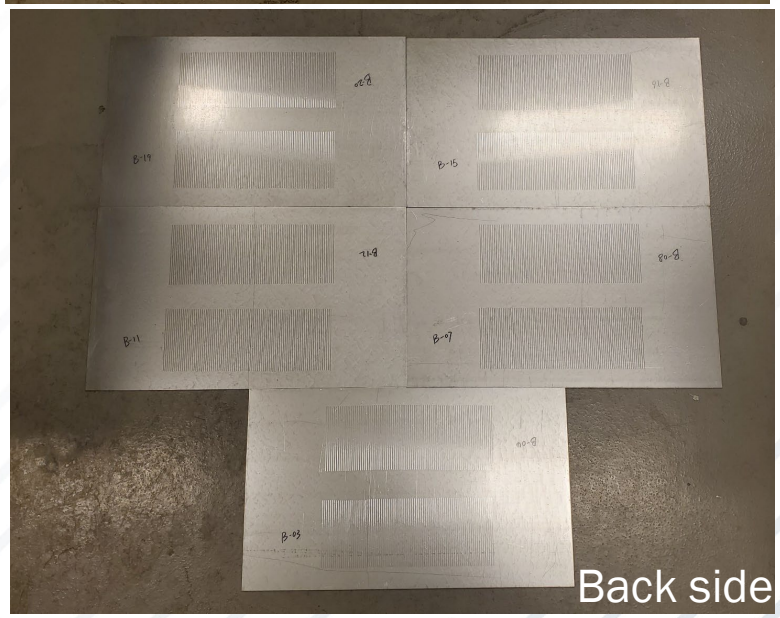
GI against Pin A (Nitriding + PVD)





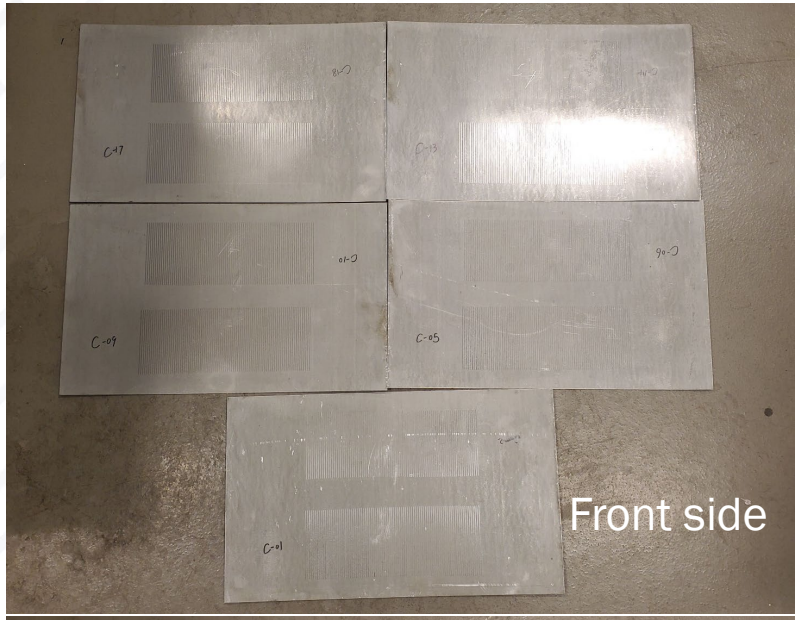
GI against Pin B (Nitriding)

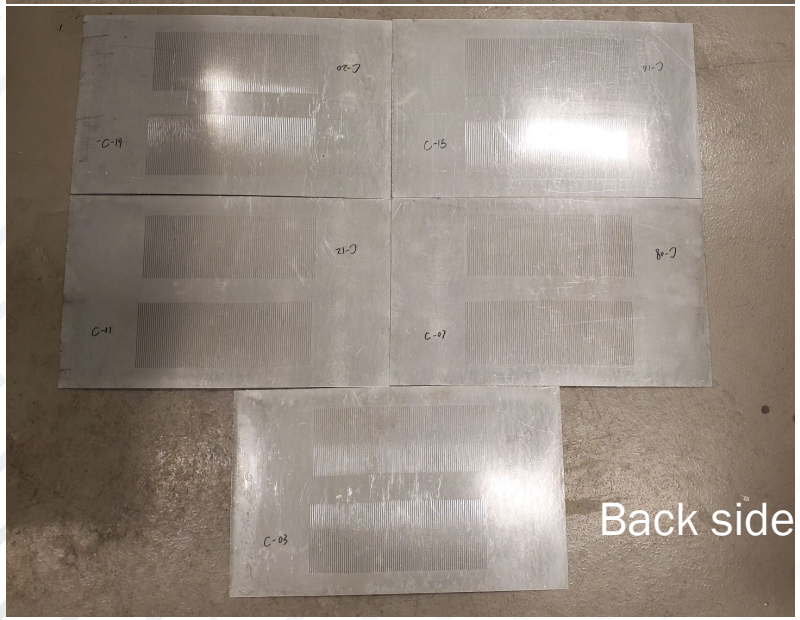




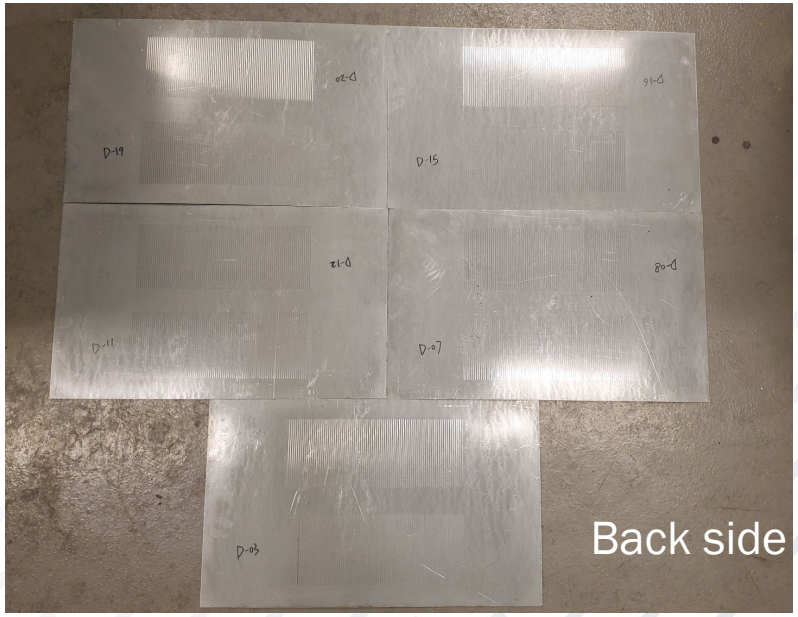
PROJECT RESULTS (WEAR TESTED SHEET SAMPLES)

EG against Pin C (Nitriding + PVD)

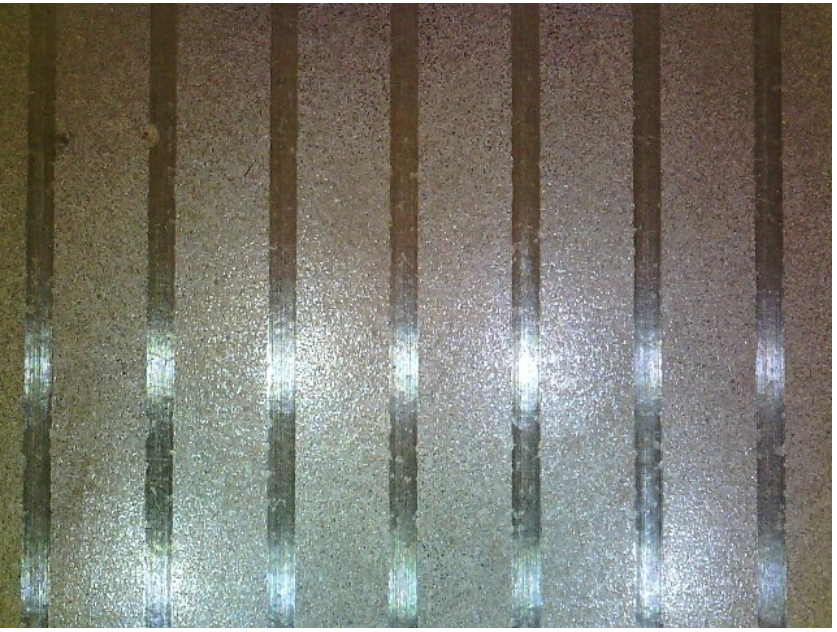




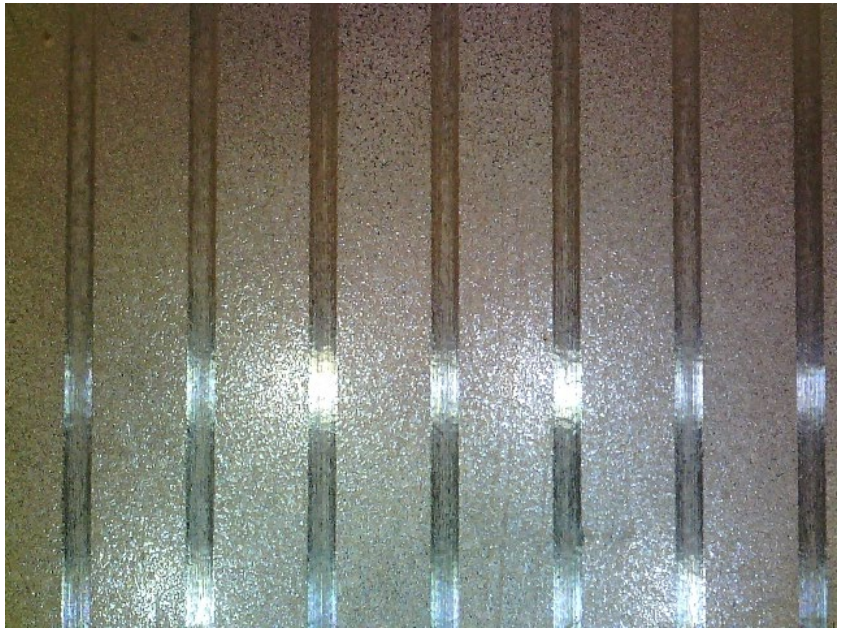
EG against Pin D (Nitriding)



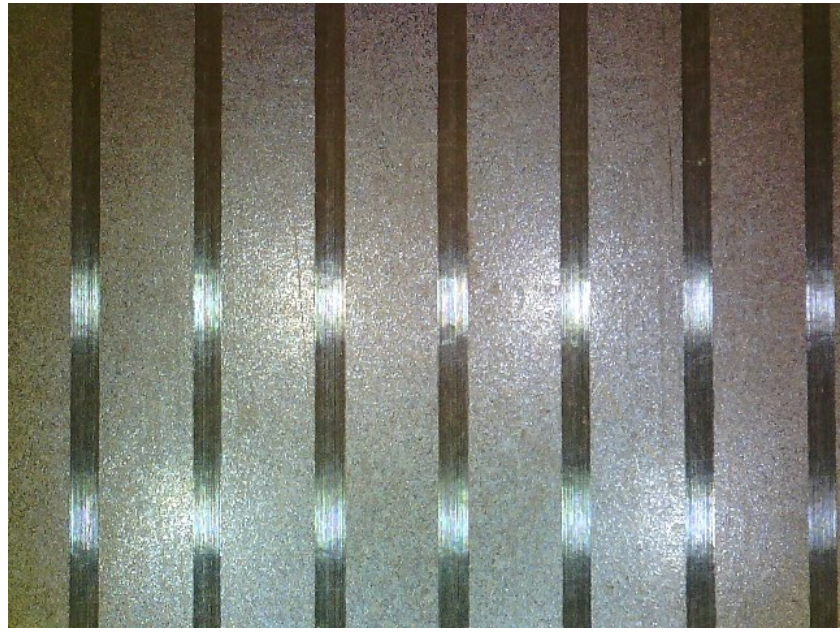
PROJECT RESULTS (WEAR TESTED SHEET – PIN A)



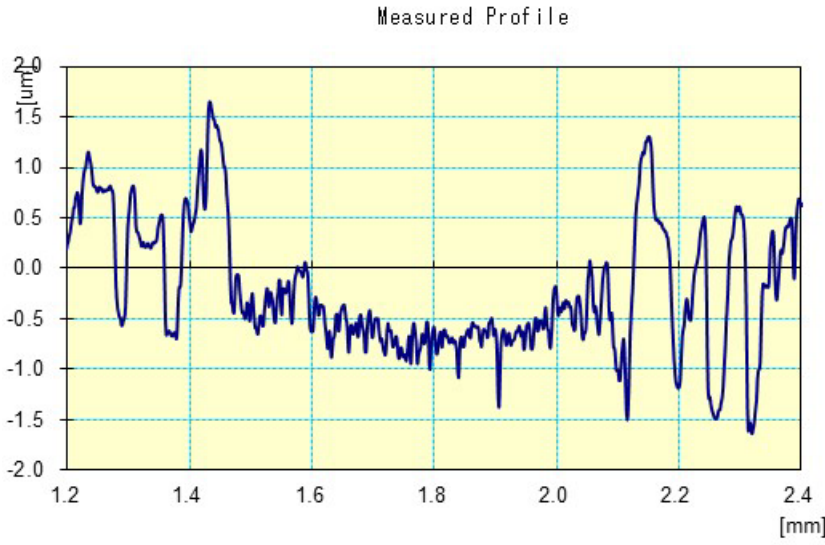
Pin A test #1 (1st steel plate)



Pin A test #11 (3rd steel plate)

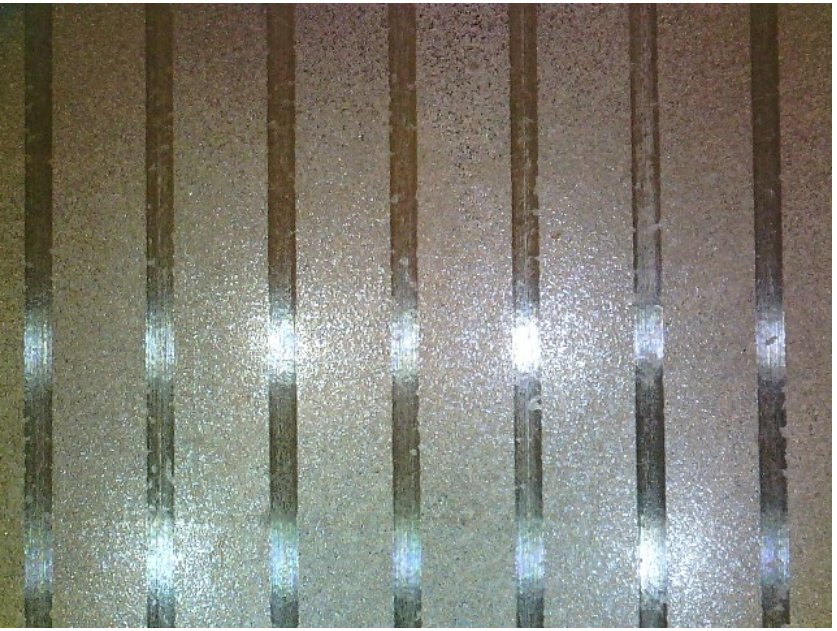


Pin A test #20 (5th steel plate)



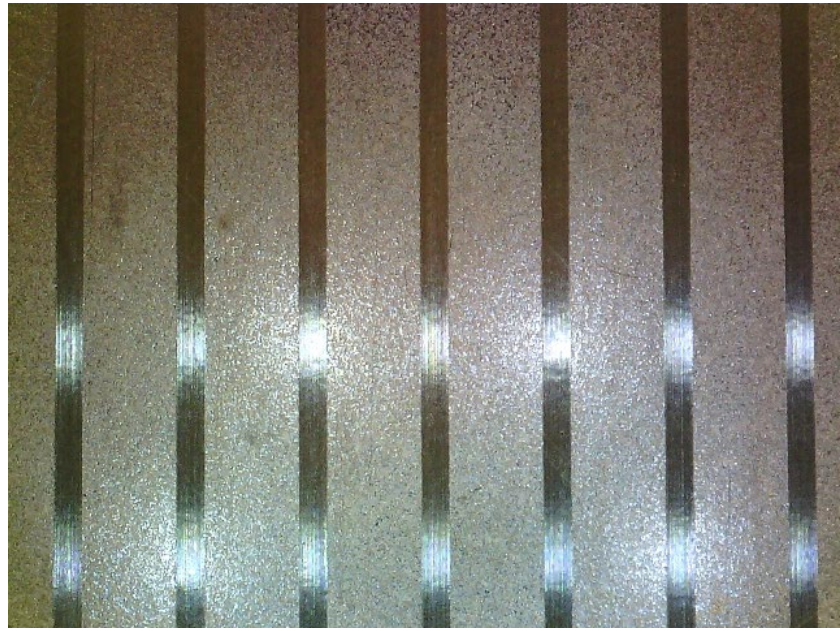
Pin A (Nitriding + PVD) vs GI coated sheet steel

PROJECT RESULTS (WEAR TESTED SHEET – PIN B)

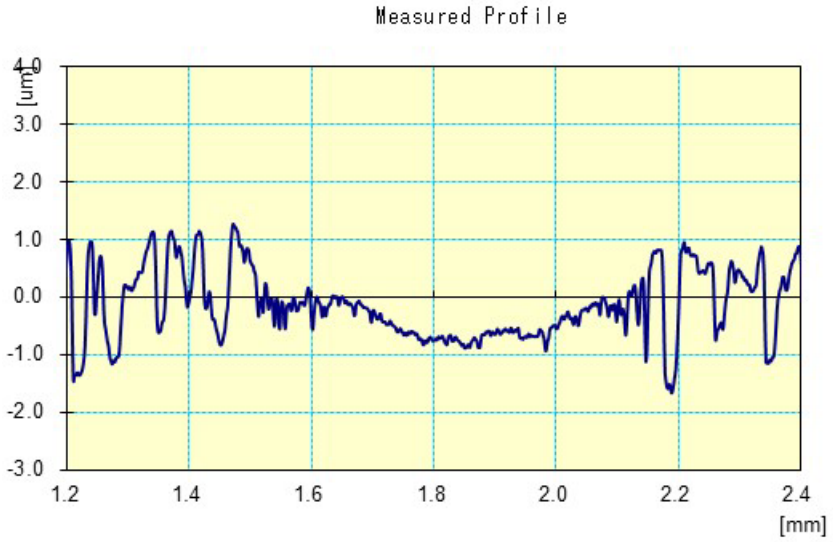


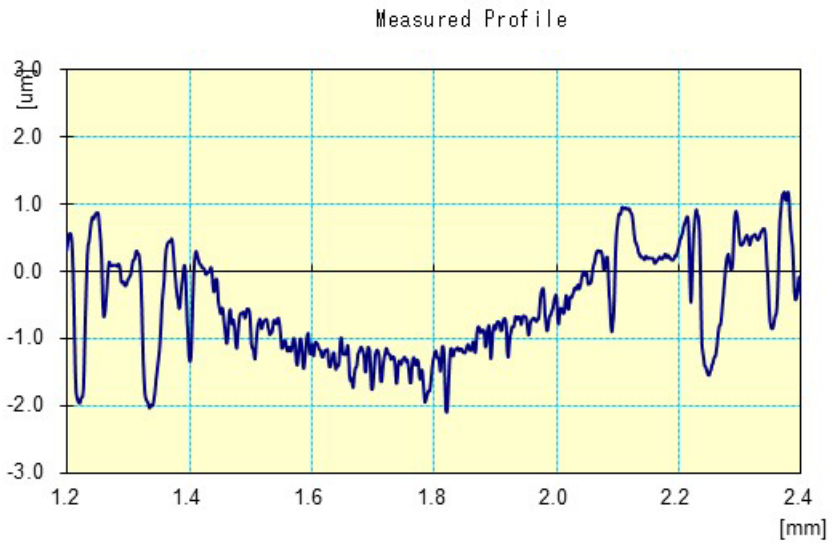
Pin B test #1 (1st steel plate)

Pin B test #11 (3rd steel plate)



Pin B test #20 (5th steel plate)

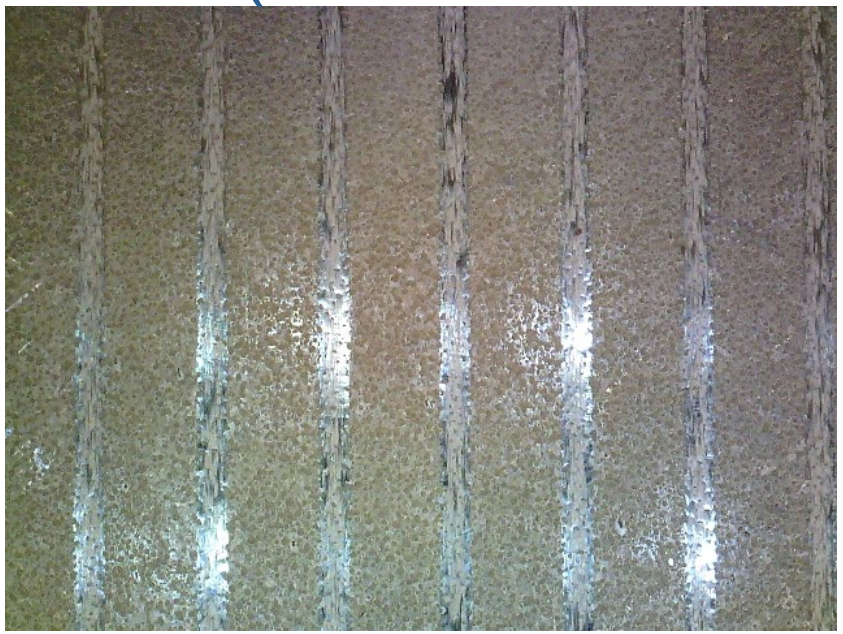




Pin B (Nitriding) vs GI coated sheet steel

PROJECT RESULTS (WEAR TESTED SHEET – PIN C)

Pin C test #1 (1st steel plate)



Pin C test #11 (3rd steel plate)

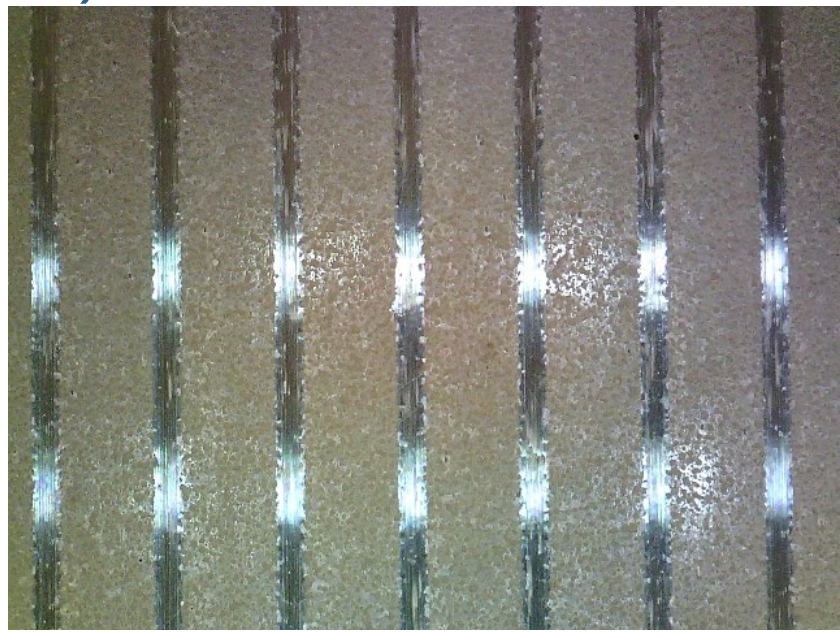
Pin C test #20 (5th steel plate)

Pin C (Nitriding + PVD) vs EG coated sheet steel

PROJECT RESULTS (WEAR TESTED SHEET – PIN D)

Pin D test #1 (1st steel plate)

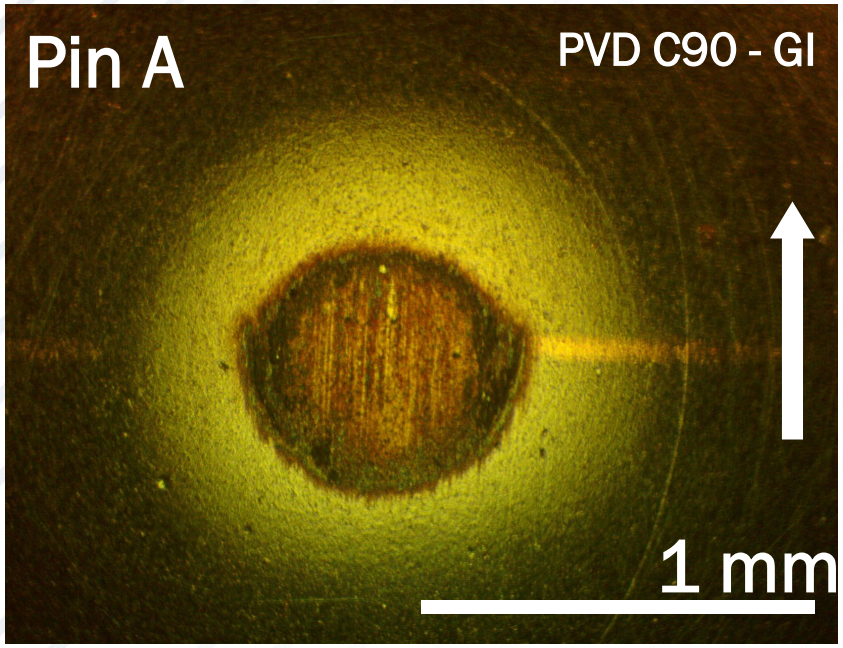
Pin D test #11 (3rd steel plate)

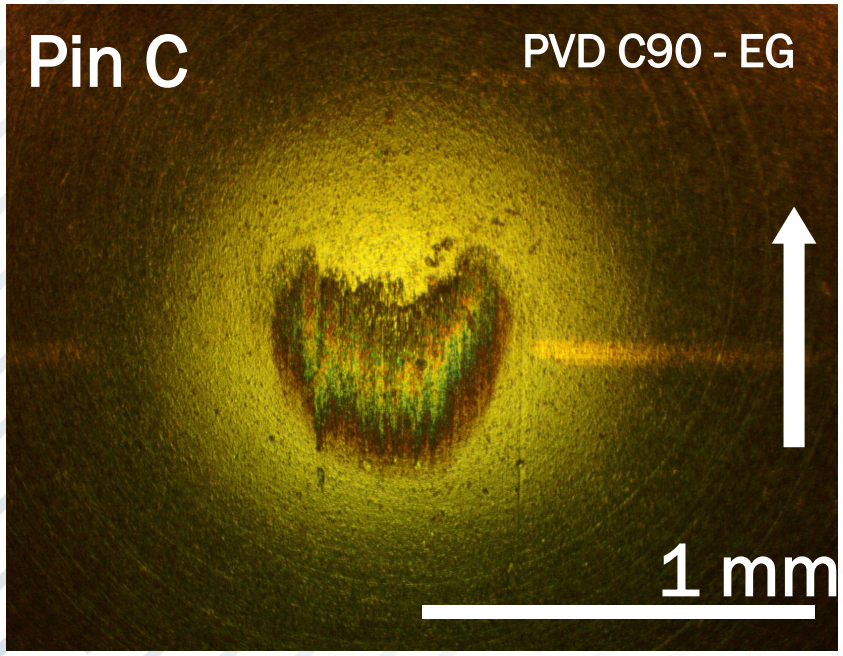


Pin D test #20 (5th steel plate)

Pin D (Nitriding) vs EG coated sheet steel

PROJECT RESULTS (COMPARISON OF DIE PIN SURFACES AFTER TESTING)

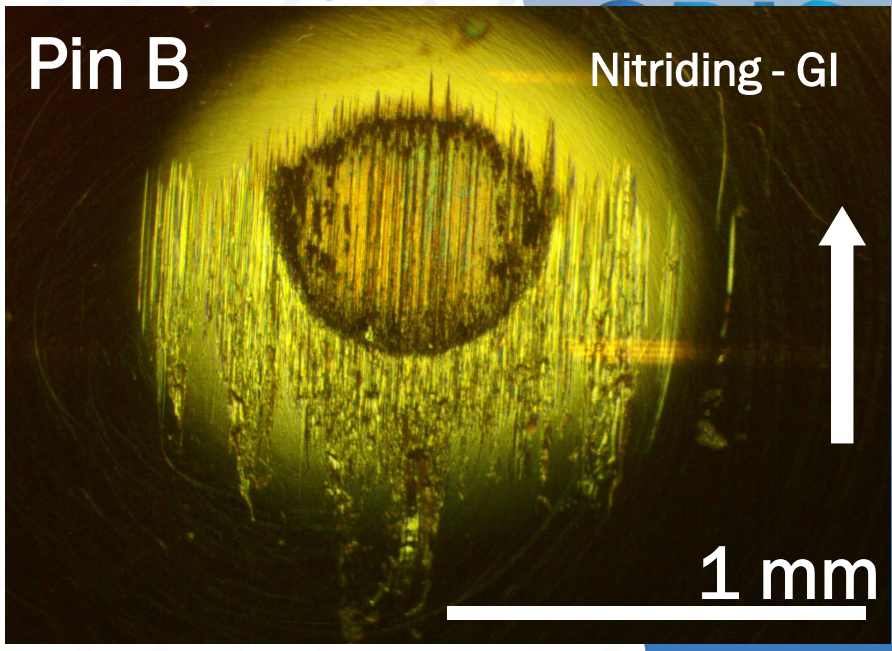


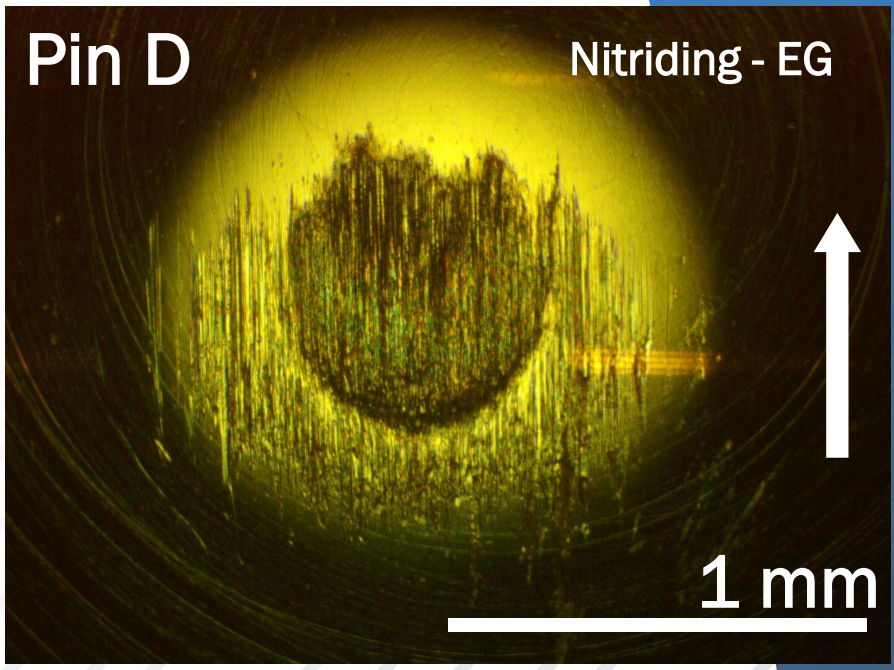


Pin #	Wear Area (mm2)
A	0.392
B	1.033 (0.330)
C	0.252
D	0.916 (0.378)

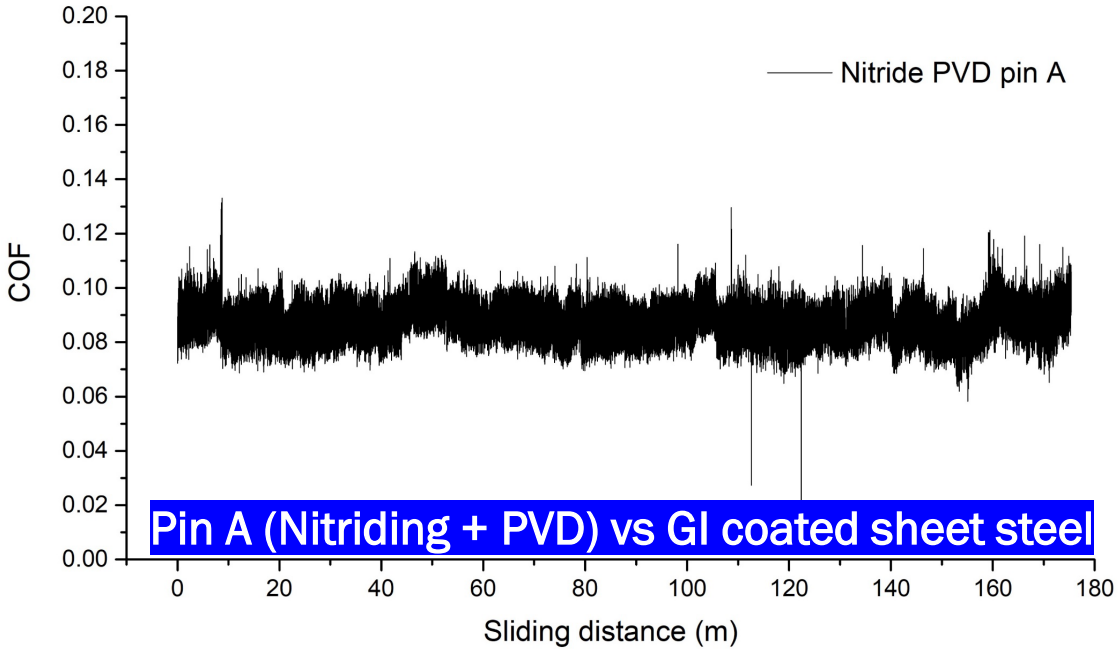
A&C PVD C90
B&D Nitriding

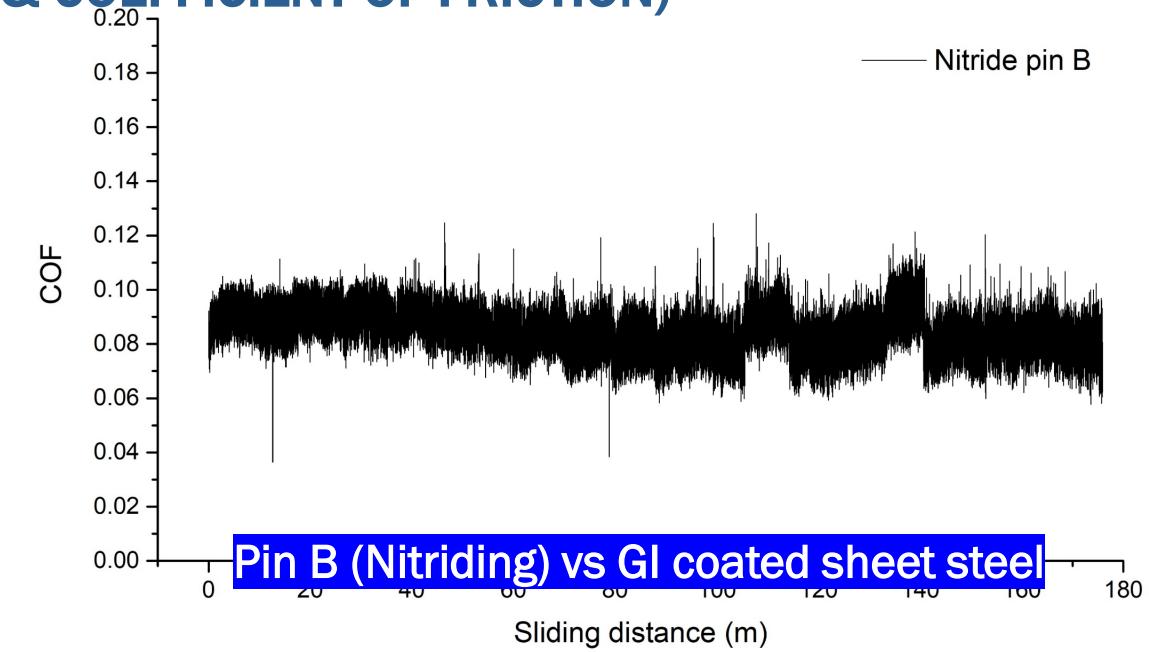
A&B GI
C&D EG

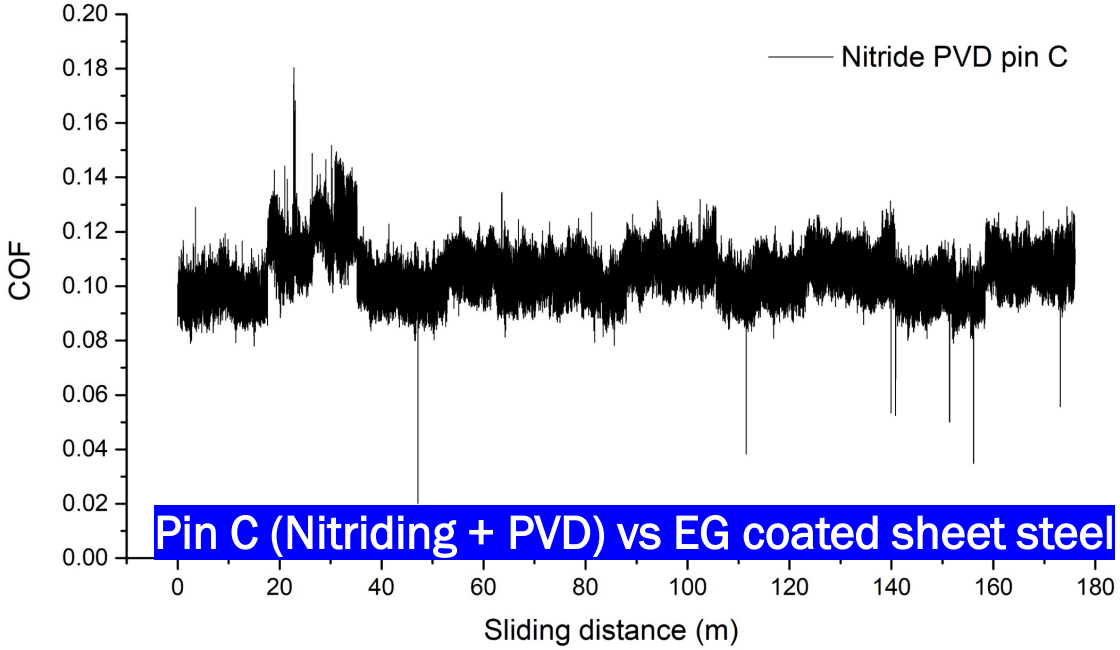


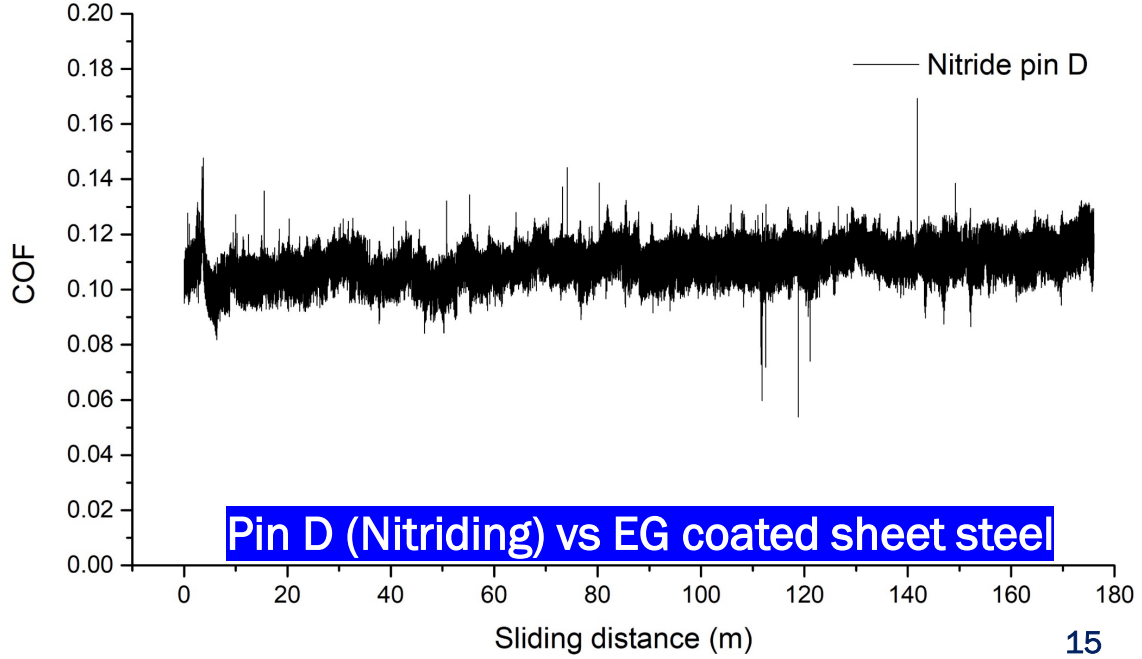


PROJECT RESULTS (DIE MATERIAL/COATING & COEFFICIENT OF FRICTION)

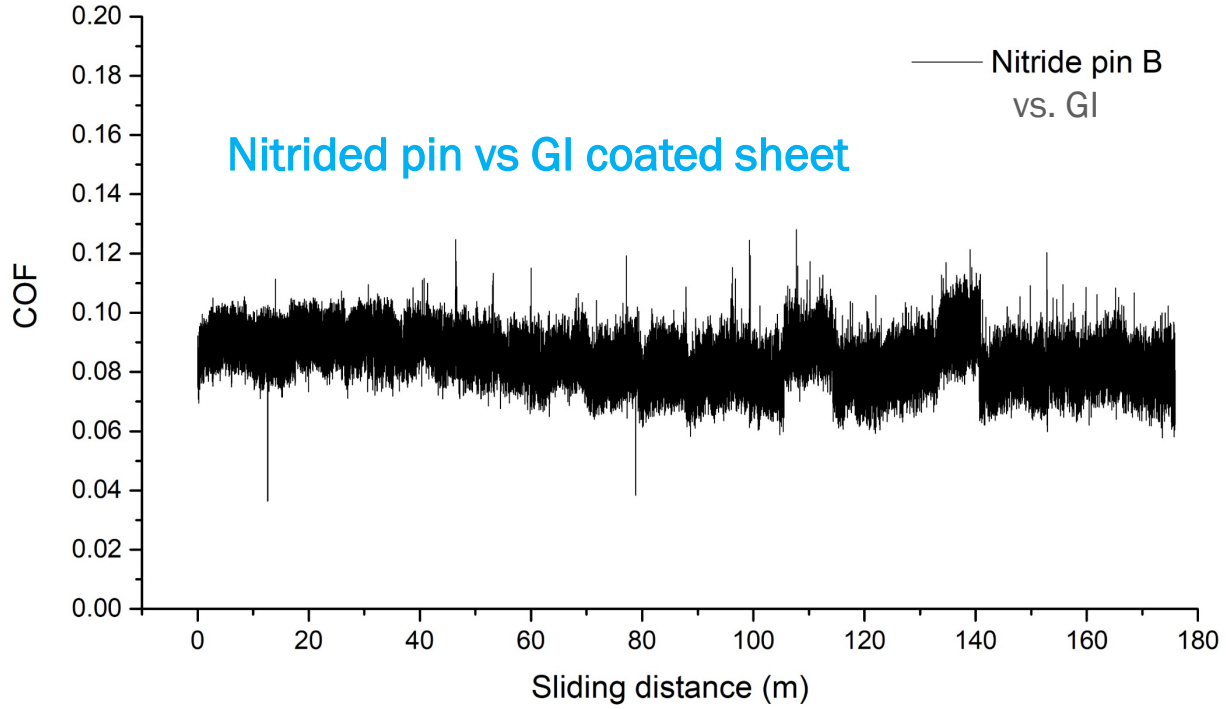


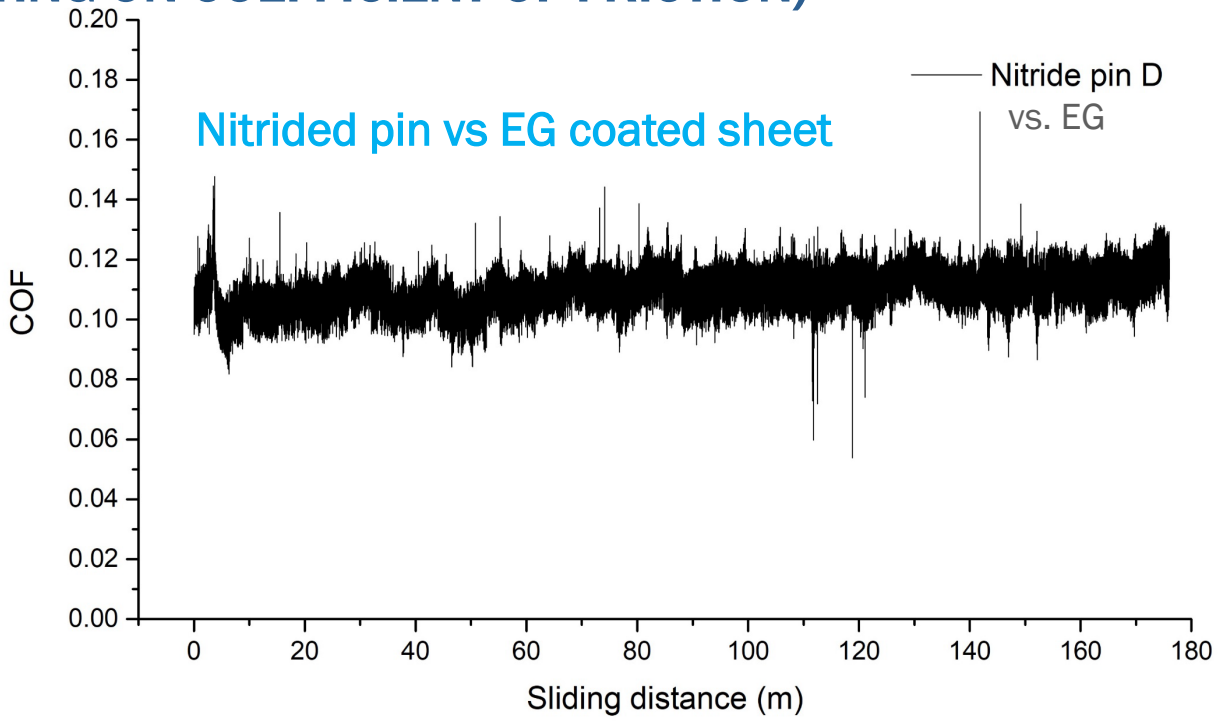






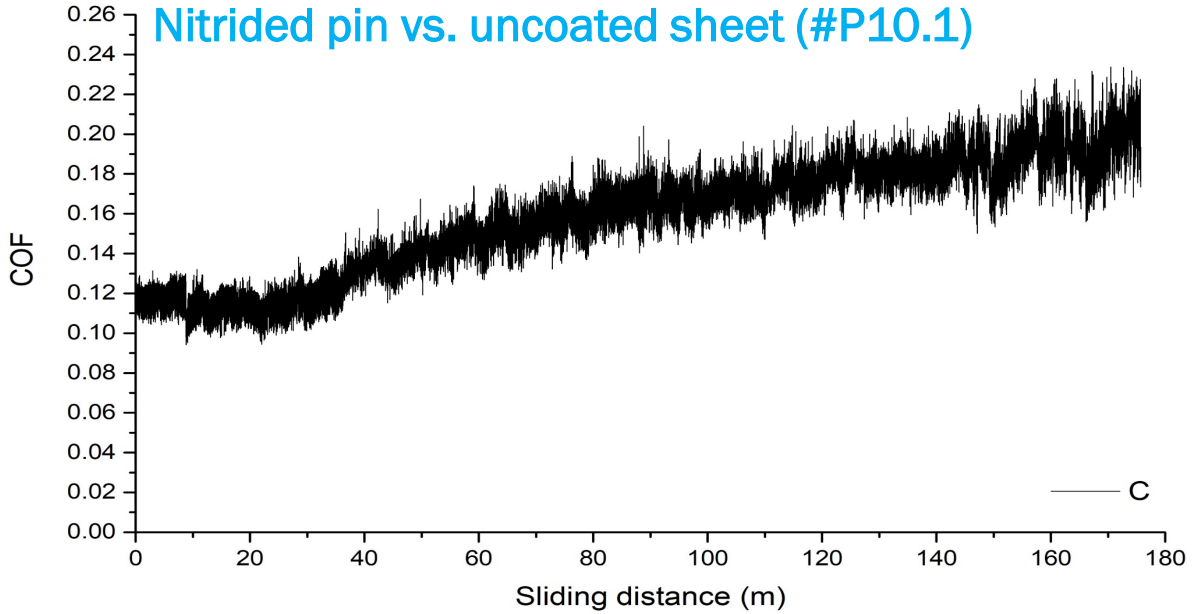
PROJECT RESULTS (EFFECT OF COATING ON COEFFICIENT OF FRICTION)



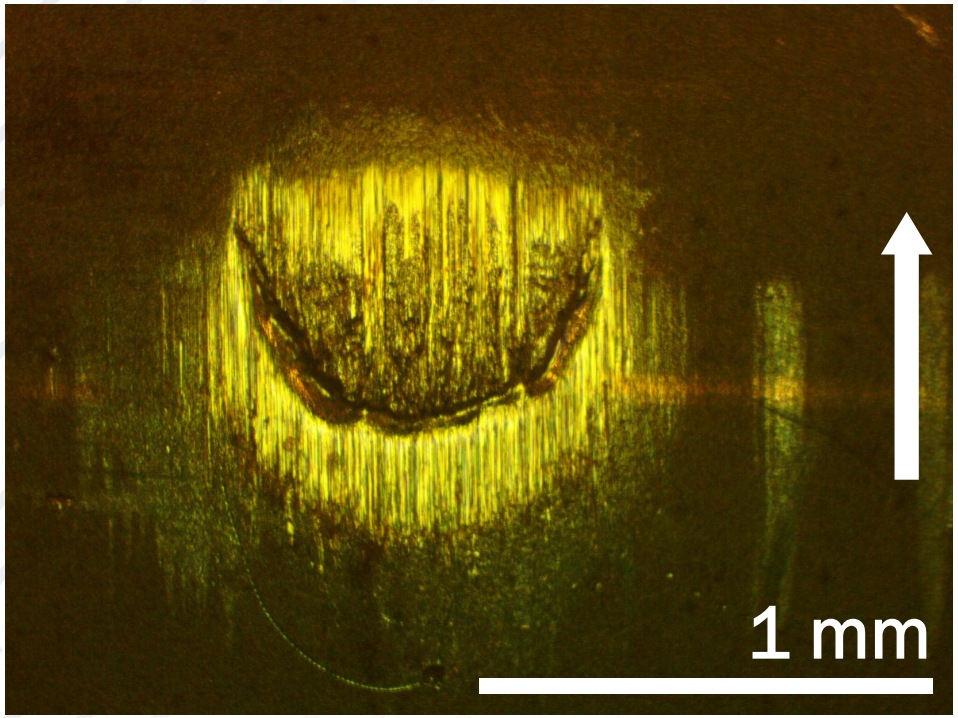


Comparison

- The GI-coated metal sheet shows a slightly lower friction than the EG-coated sheets.
- The GI and EG coatings on sheets with the lubricant oils significantly reduced coefficient friction, compared with G3 uncoated sheets.



PROJECT RESULTS (P#10.1 COMPARISON – UNCOATED GEN3 1180)



Pin Wear Area = 1.512 mm2 (0.789 mm^2)

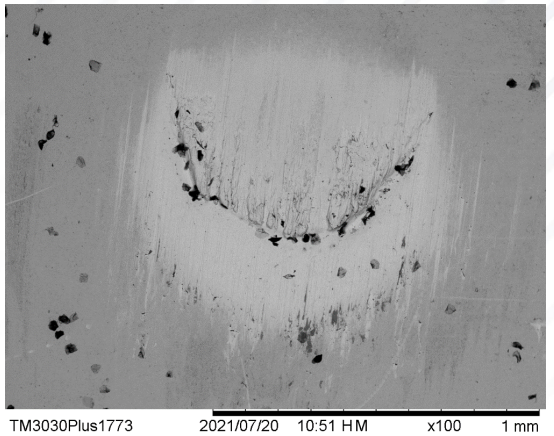
Comparison with STO 10.1 result

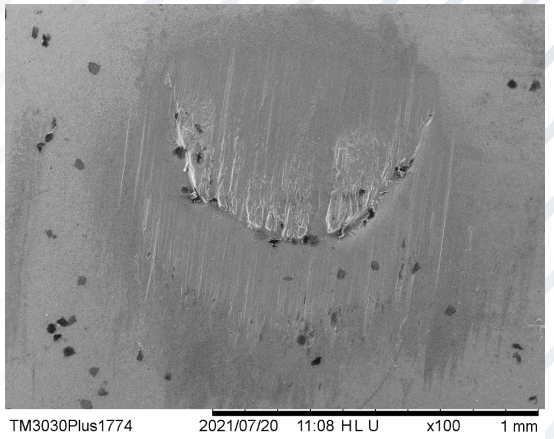
Lot #175 3rd Gen 1180 uncoated sheets (DIMENSIONS: 300mm (T) x500mm (R) x1.6mm)

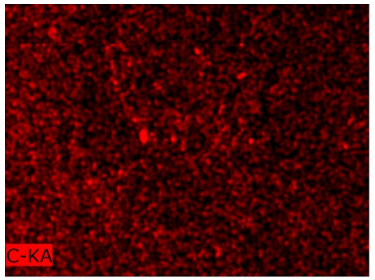
Die material = bar stock Caldie

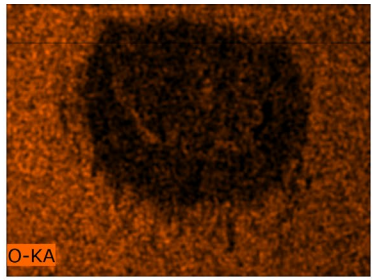
Die surface treatments = Q+T+Nitriding

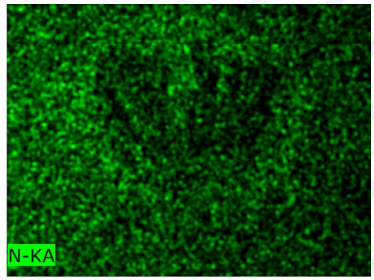
Lube conditions = 1g/sm

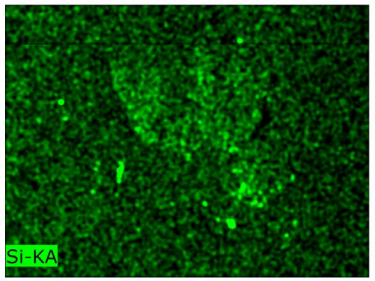


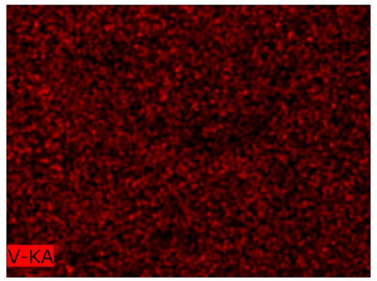


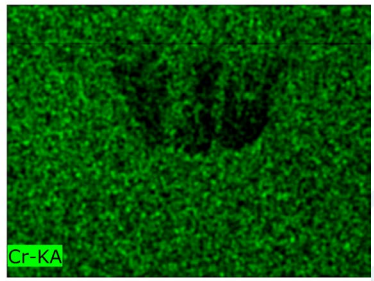


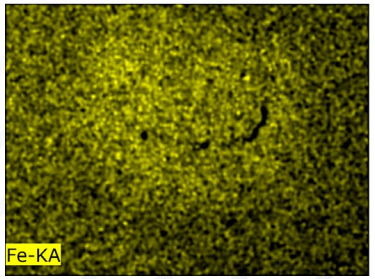


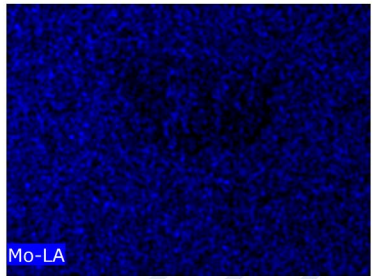




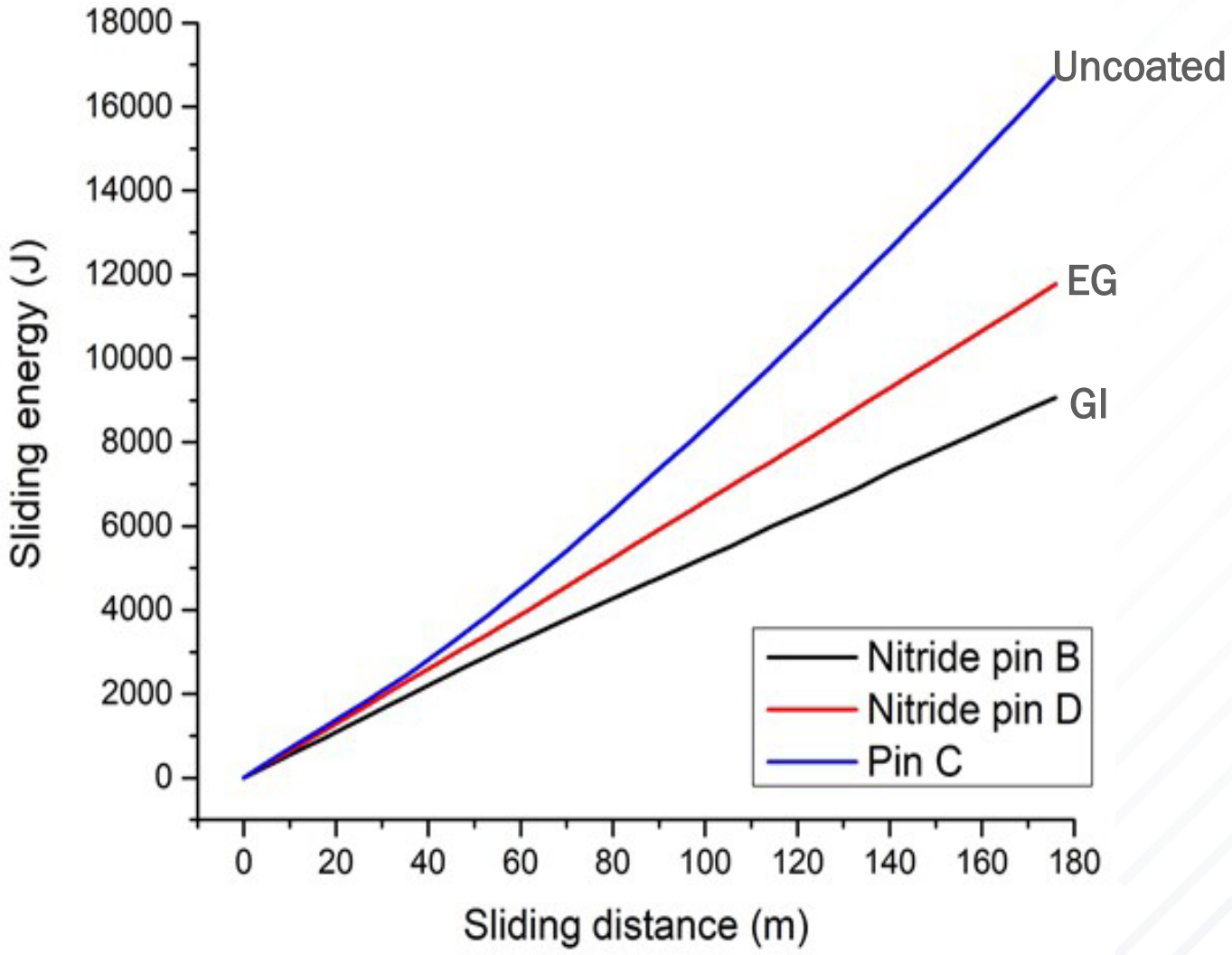








PROJECT RESULTS (EFFECT OF COATING ON SLIDING WEAR ENERGY)



Sheet Materials	Pin treatment - Nitriding
CR1000Y1180T-RA-SE-GI	Pin B
CR825Y1180T-DP-EG	Pin D
Gen 3 1180 (STO 10.1)	Pin C of STO 10.1

Comparison

The GI-coated metal sheet leads to lower sliding energy than the EG-coated sheet when against Nitrided pins. The GI and EG coatings with lubricant oils, on sheet metals can significantly reduce sliding energy, compared with AHSS uncoated material

PROJECT CONCLUSIONS AND RECOMMENDATIONS

- The sheet steels with GI coating (CR1000Y1180T-RA-SE-GI) showed a lower coefficient of friction and associated sliding energy than those with EG coating (CR825Y1180T-DP-EG)
- The GI and EG zinc coatings on sheets with the lubricant oils can significantly reduce coefficient of friction and sliding energy as compared with comparable strength uncoated steels
- The sliding energy was similar for both PVD C90 coated and nitrided pins against GI coated sheet steel (CR1000Y1180T-RA-SE-GI) while the energy was higher for the nitrided pin than for the PVD C90 pin when compared against CR825Y1180T-DP-EG sheet
- The wear marks on pins sliding on similarly coated steels were found to be comparable
- Some of the GI and EG coatings were was found to have transferred from the sheets onto both the PVD C90-coated pins (Pins A and C) and nitrided pins (Pins B and D)

Good die heat treatment and coatings are necessary to drive acceptable die surface conditions, frictional behavior and resulting stamping performance, which zinc coatings aid further, to help improve part quality for high volume production of 3rd Gen ultra high strength steels.

PROS AND CONS

Advantages:

This test more closely represents the contact and sliding condition in the real stamping production

Disadvantages:

Limited sliding distance in the test

NEXT STEPS

Preform additional production related sliding wear tests with OEM selected combination of UHSS sheet, die materials and surface treatments are planned in STO 10.3 phase.

FOR MORE INFORMATION

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More Questions? Meet the speaker(s) the Auto/Steel Partnership booth.

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