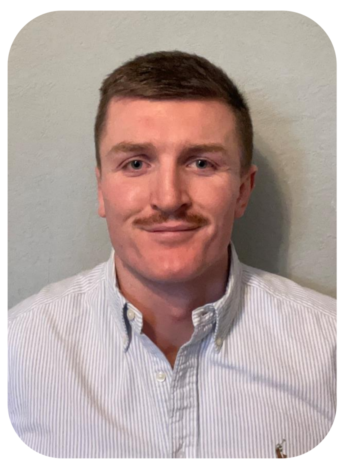


**Name:** Jamie Williams
**University:** Swansea University
**Sponsoring Company:** TATA Steel
**Academic Supervisors:** Dr. Eifion Jewell, Prof. Trystan Watson
**Industrial Supervisor:** Dr. Clive Challinor


**INTRODUCTION** This project involves the investigation of current surface treatments applied to metallic-coated steel on a continuous galvanising line. Organic and inorganic coatings are applied to the sheet steel via a roller coating process, adding overall value and making the product more appealing for customers. The project also investigates potential, novel coatings that may add functionality to the product. Coatings that can be applied might include those that prevent corrosion, improve lubricity or add a smart functionality. In addition, the current roller deposition process is being evaluated to maximise its current effectiveness.

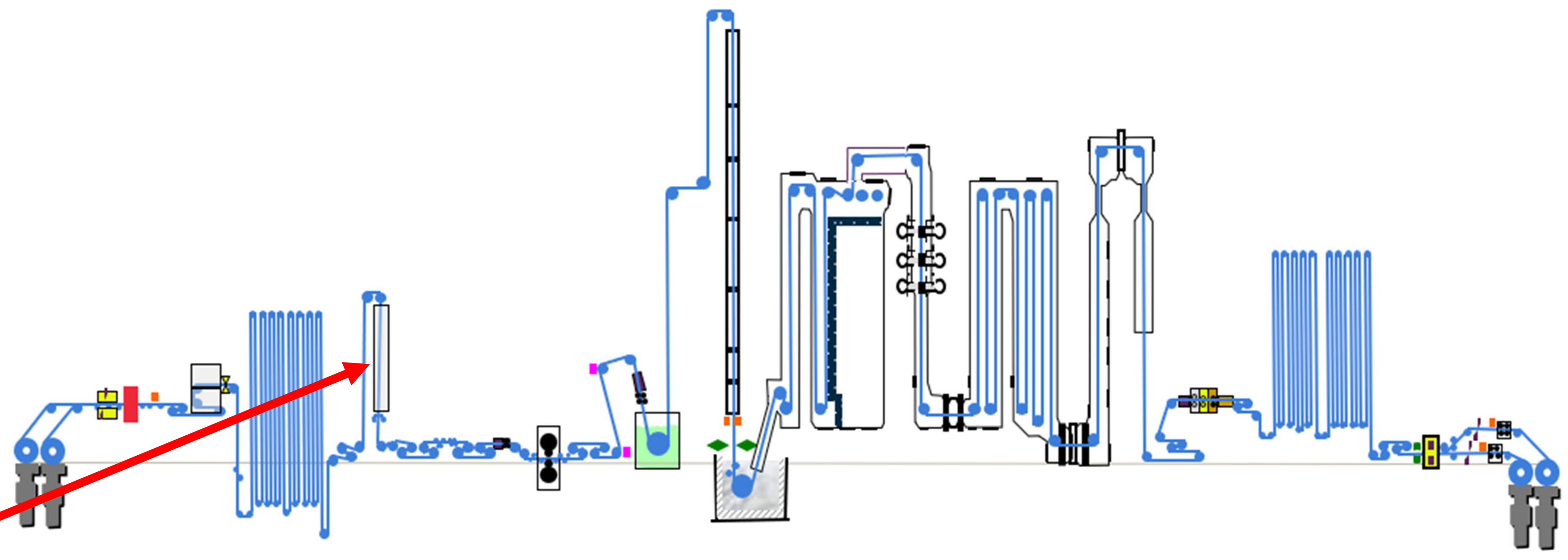

*Figure 1. - Schematic of HDG line at ZODIAC, Llanwern.*

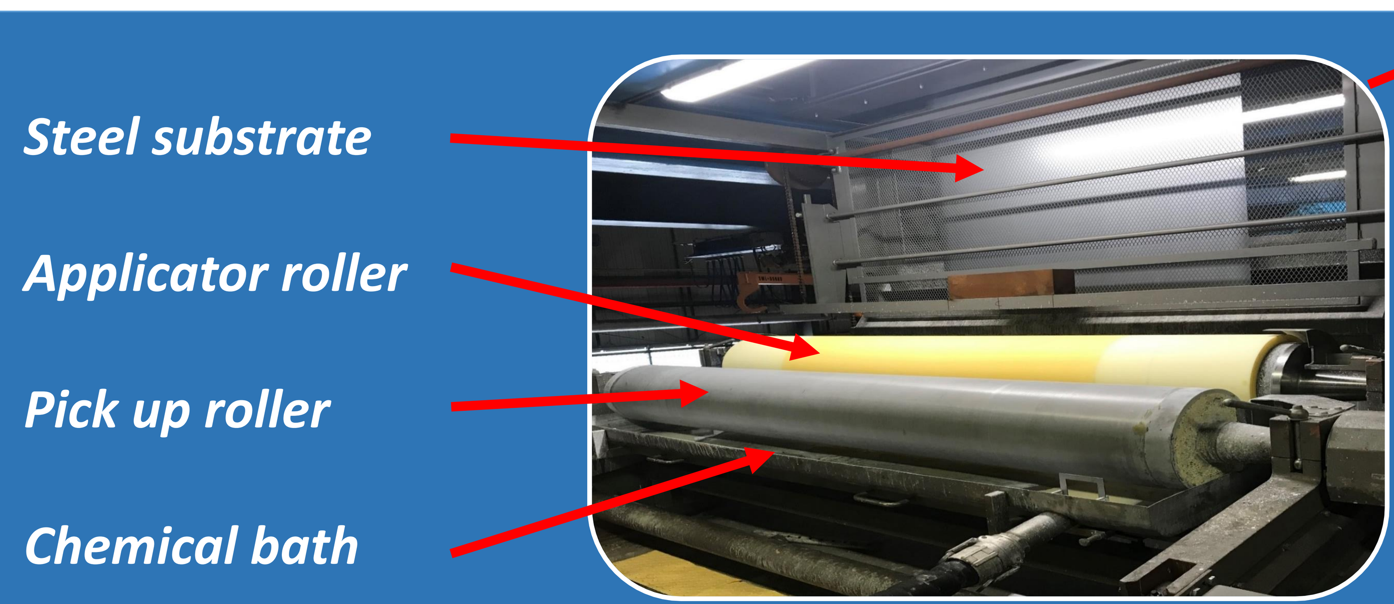


*Figure 2 – Chemcoater apparatus*

**ROLLER COATING** An engrained pick-up roller transfers a coating liquid onto an applicator roll, which subsequently coats the substrate via a thin liquid web. The gap between the adjacent rolls and the speeds at which they run, determine the thickness of the coating.

**PRIMECOAT** Passivation of galvanised steel by employing a phosphate coating to the zinc layer. Aids corrosion resistance, whilst improving adhesion properties at the surface.

**PLT** Booster lubricant developed to reduce friction coefficient, reducing tribological defects when pressed. Applied below an oil layer.

# DEVELOPMENT OF SURFACE TREATMENTS FOR THE AUTOMOTIVE INDUSTRY UTILISING THE CHEMCOATER

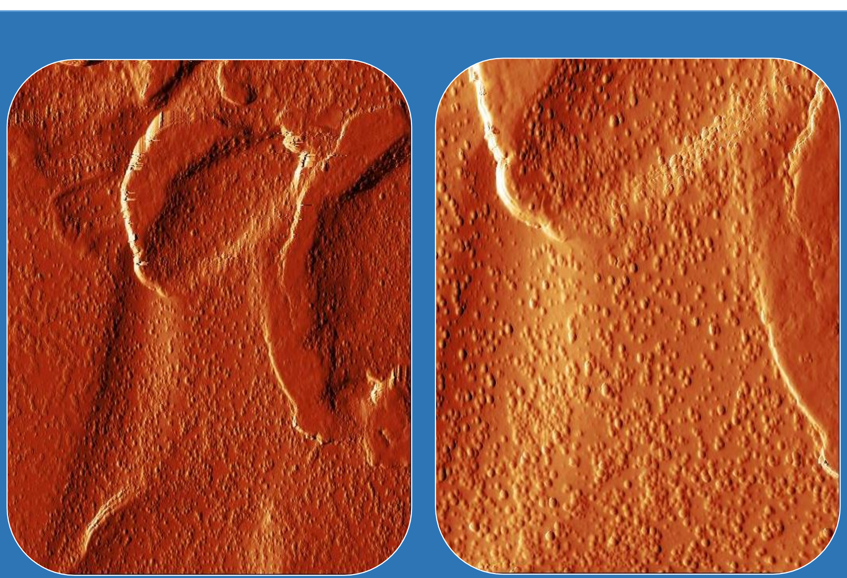

*Figure 3 - AFM error signal reading of PLT, coating weight = 19.5mg/m².*

**SIMULTANEOUS THERMAL ANALYSIS** (differential scanning calorimetry and thermal gravimetric analysis) This analysis demonstrated similar thermal transition behaviour for both coatings, indicating similar drying conditions.

**X-RAY FLOURESCENCE ANALYSIS** is a NDT used to quantitively determine the weight of an element on a substrate's surface. Tracer element, P, should be measured at 5-10 $mg/m^2$ and 60-80 $mg/m^2$ for PLT and Primecoat, respectively.

**ATOMIC FORCE MICROSCOPY** Is a surface analysis method. Where the attractive forces at the surface cause cantilever deflection. Deflection is detected and translated into a topographical image.

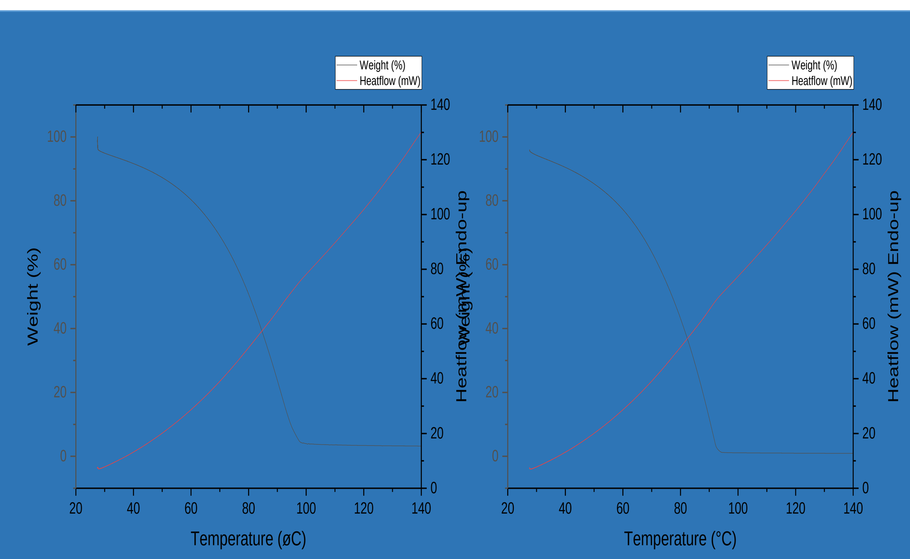


*Figure 4 - STA results of PrimeCoat and PLT solutions respectively.*

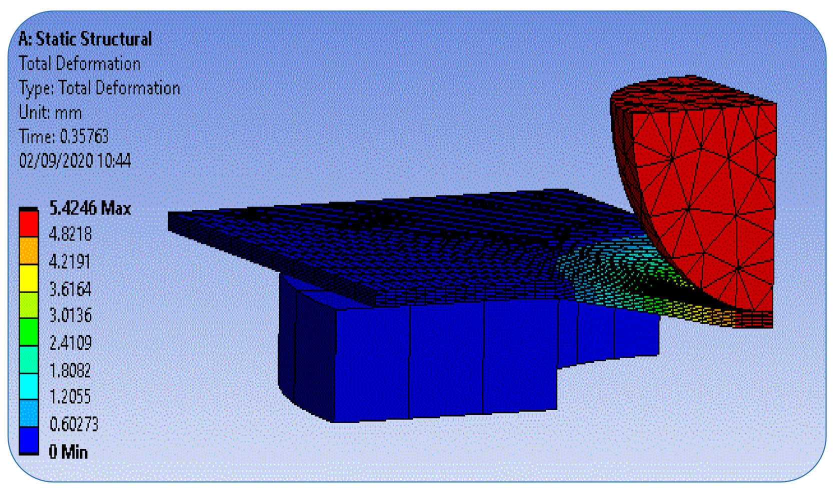


*Figure 5 – Side profile of simulation for Erichsen cupping test.*

**LUBRICITY ANALYSIS** The relationship between coefficient of friction (CoF) and steel's formability was studied to understand its performance when in contact with tooling. Reduced CoF may lead to considerably better drawing performance, reducing surface defects like scratching and galling. A simulation model was created mimicking the Erichsen test, with the aim of producing an accurate model to predict future substrate deformation. Linear friction testing was carried out with two sheets of coated substrate in direct contact with each other. Mean CoF values were found to be 0.26 and 0.12 for Primecoat and PLT respectively.

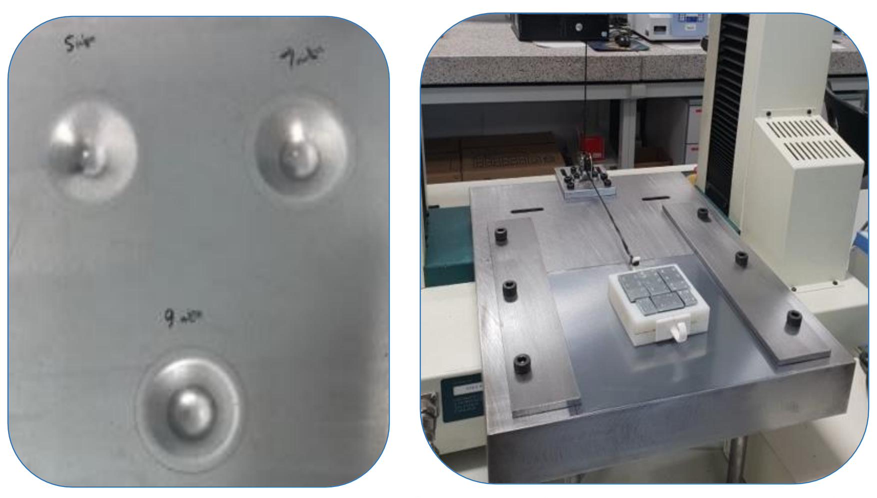

*Figure 6 – Sample after Erichsen cupping and linear friction testing apparatus set up compliant with BS EN ISO 8295:2004.*

**DEVELOPMENT OF NOVEL COATINGS** It is desirable for replacements of chromium-based treatments to show smart properties. For example, the use of thin coatings can exhibit desirable functional characteristics, including self-lubricating, self-cleaning, anti-fingerprint, and self-healing properties. These properties may add increased value to the product and be appealing for customers. As the project progresses, I intend to investigate the following chemical additions and study their smart characteristics.

- Cerium Nitrate, **$Cr(NO_3)_3$** - Self-healing and improved corrosion performance [1]
- Titanium Dioxide, **$TiO_2$** - Hydrophobic and improved corrosion performance
- Silicon Dioxide, **$SiO_2$** - Super Hydrophobic and improved corrosion performance [2]

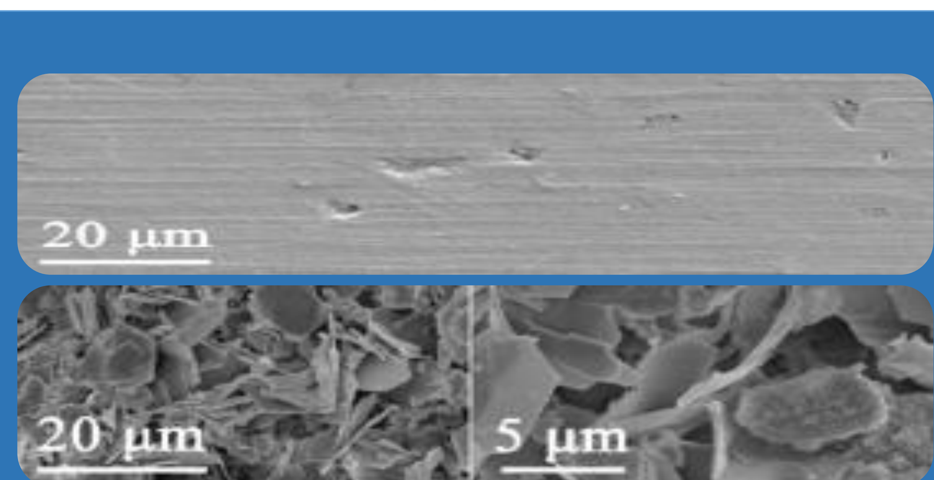


*Figure 7 – FESEM of untreated HDG steel and steel treated with $SiO_2$ (1% wt.). The morphology of treated steel showed uniform staggered layer distribution of flocculles, increasing surface roughness and hydrophobicity [2].*


**REFERENCES**

[1] Lin B, Lu J. Self-healing performance of composite coatings prepared by phosphating and cerium nitrate post-sealing. Journal of Wuhan University of Technology-Mater Sci Ed. 2015;30(4):813-817.

[2] Liang T, Yuan H, Li C, Dong S, Zhang C, Cao G et al. Corrosion inhibition effect of nano–SiO2 for galvanized steel superhydrophobic surface. Surface and Coatings Technology. 2021;406:126673.



Swansea University Prifysgol Abertawe
Engineering and Physical Sciences Research Council
Cronfa Gymdeithasol Ewrop European Social Fund