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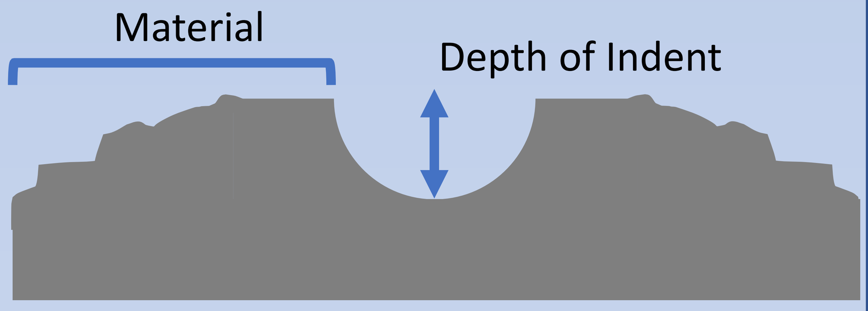
Investigating Formability of Future Steel Grades Using Rapid Alloy Prototyping

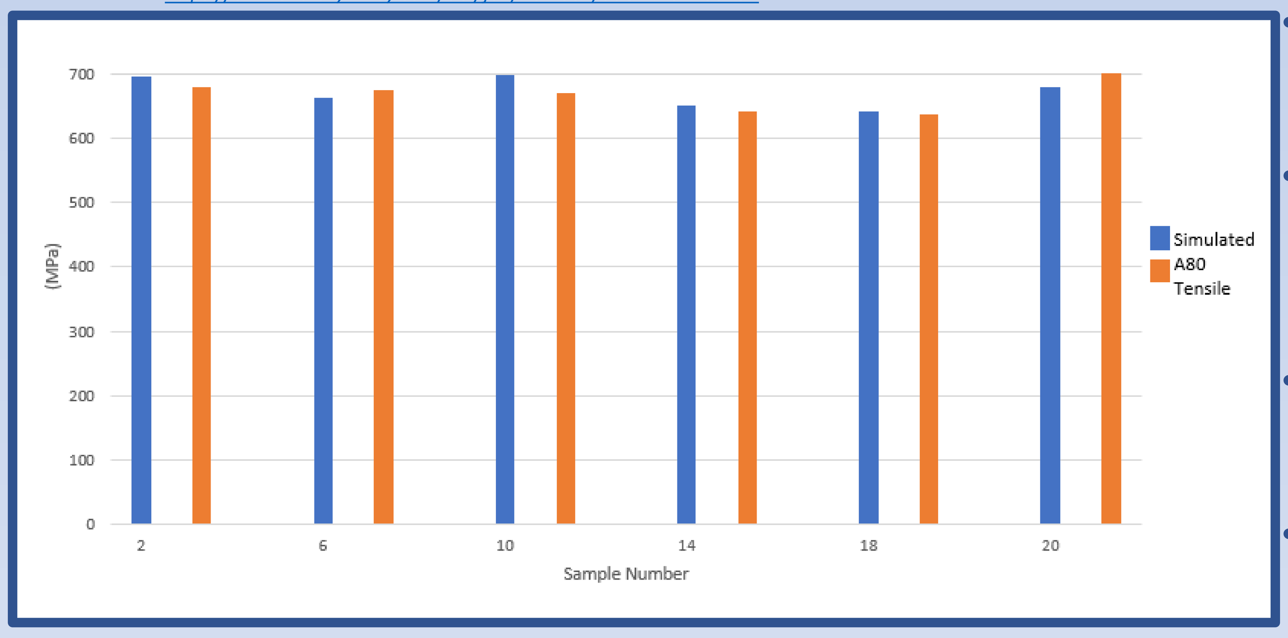
Swansea University Prifysgol Abertawe

Plastometrex LPX- Rapid generation of stress strain curves through indentation, profile measurement and finite element simulation.

1. Profilometry-Based Inverse Finite Element Method Indentation Plastometry, Trevor William Clyne,Jimmy Edward Campbell,Max Burley,James Dean: https://onlinelibrary.wiley.com/doi/full/10.1002/adem.202100437

Inline with the goals of the Prosperity partnership to rapidly develop novel alloys, and rapidly assess them, an asset such as the LPX Plastometrex could be key.

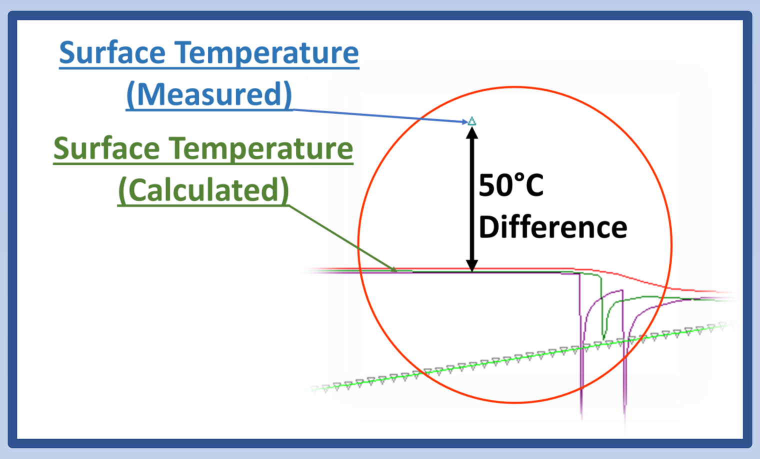




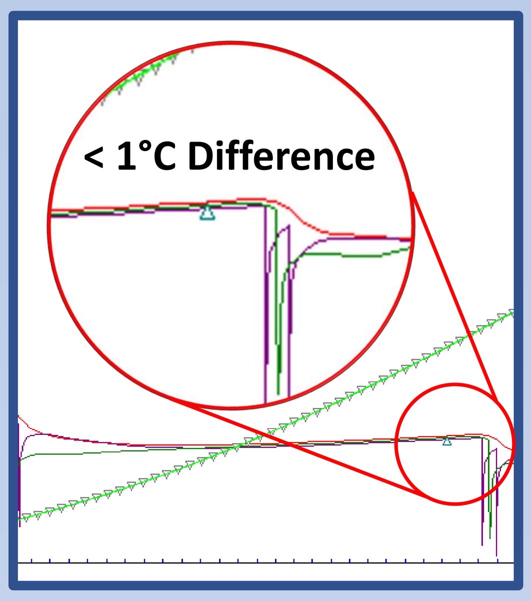
Comparison of simulated tensile UTS results and experimental UTS results from A80 samples, across 6 specimens.

- On average simulated UTS was less than 2.5% of experimental tensile value.
- The Plastometrex is capable of outputting strain at failure, strain offset, and Young's modulus.
- Tensile results generated in minutes without need to cut tensile samples
- Samples require minimal preparation (1000 grit grinding)

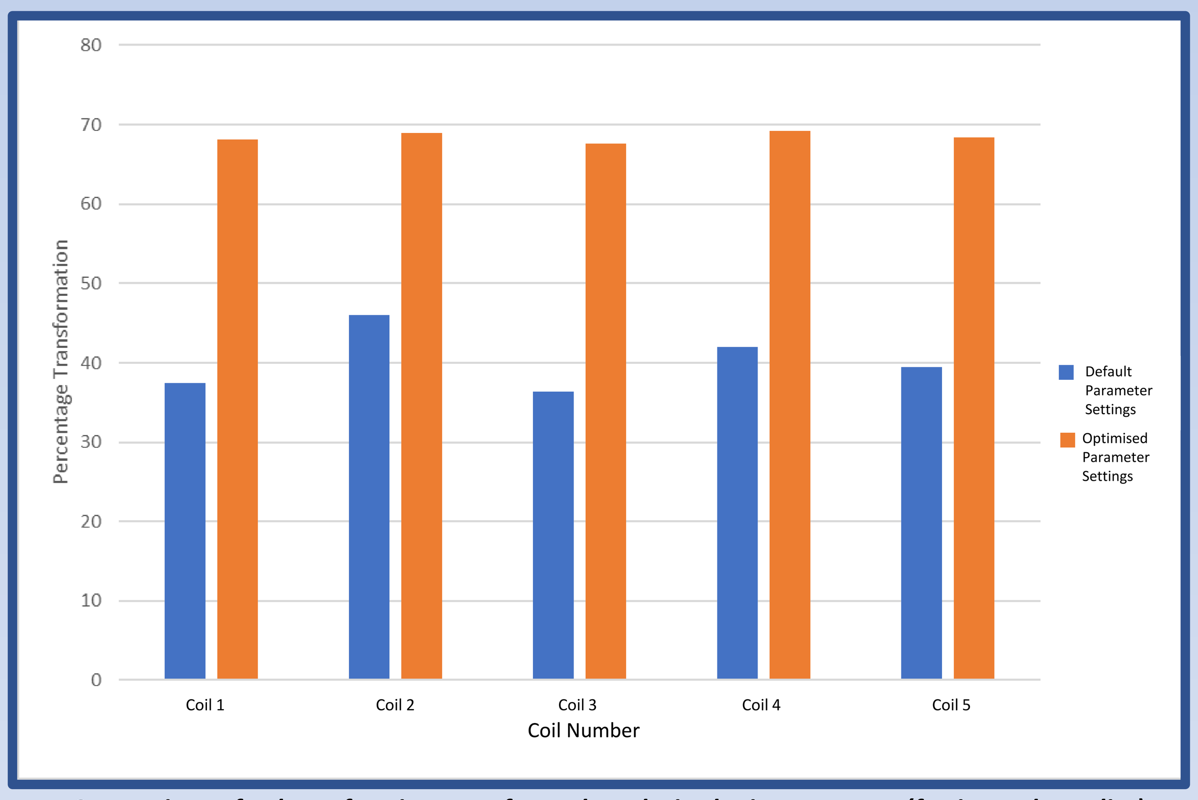
Titan ROT Optimisation for DP800- Adjusting cooling and transformation parameters such that model outputs match plant produced material. This allows in process changes to be made more easily which can aid in product consistency and therefore reduce cost.

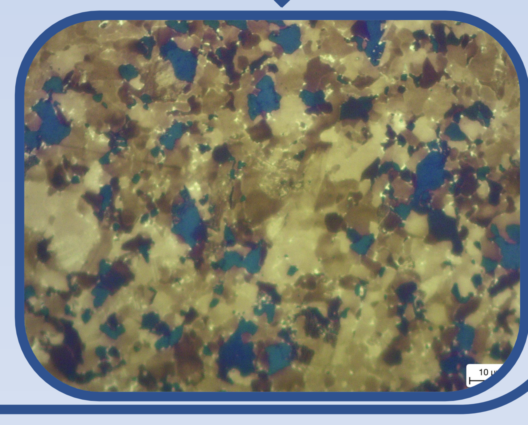


Optimisation- In model parameter modification



Analyse reported microstructure and compare to plant material

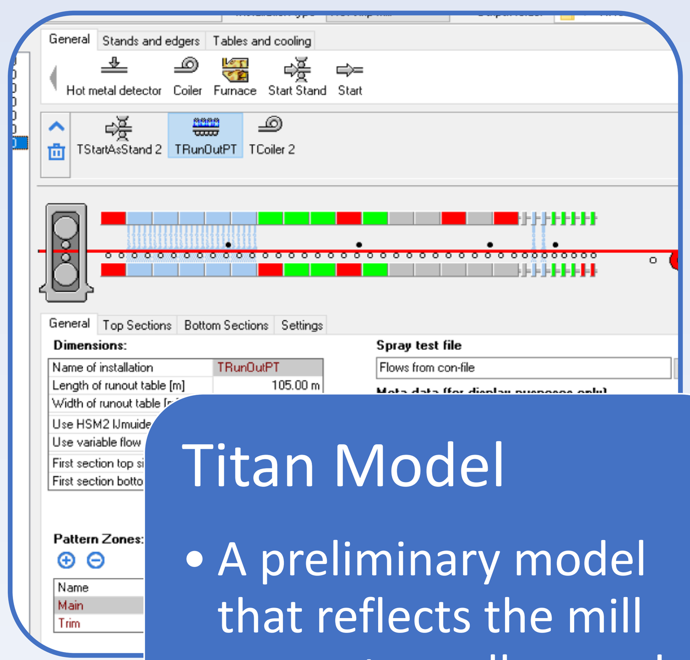




Comparison of volume fraction transformed, to desired microstructure (ferrite and pearlite), post ROT cooling, before and after in model parameter optimisation

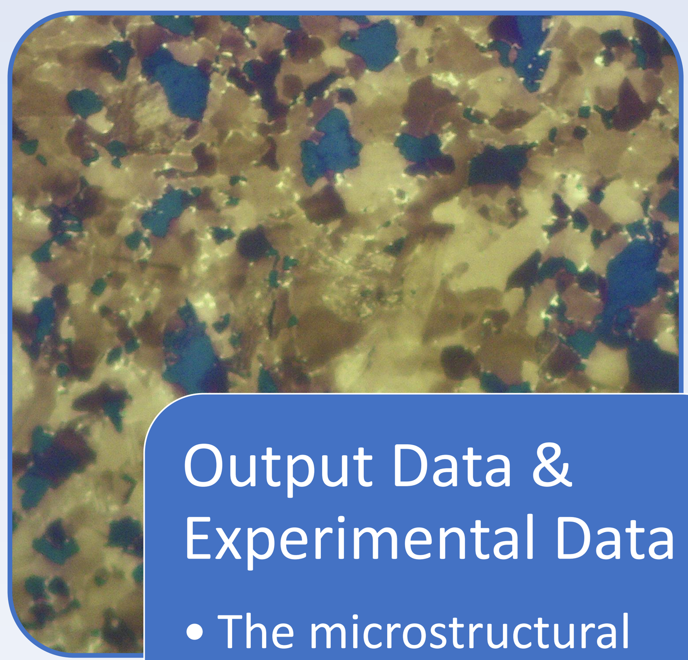
Lewis Mill (Small Scale Roller & ROT) Titan Modelling

Additionally Lewis Mill optimisation of the Titan model is also being investigated. The Lewis Mill is a lab scale pair of rollers and ROT. This will be essential in trialling novel alloys produced using Rapid Alloy Prototyping before implementing on a production scale. The Titan software is being used to model the Lewis Mill. This will result in a better understanding of the dynamics at play on a smaller scale, and therefore be a key asset in scaling up novel RAP produced alloys to a production scale. The method by which this optimisation will be achieved is outlined below:



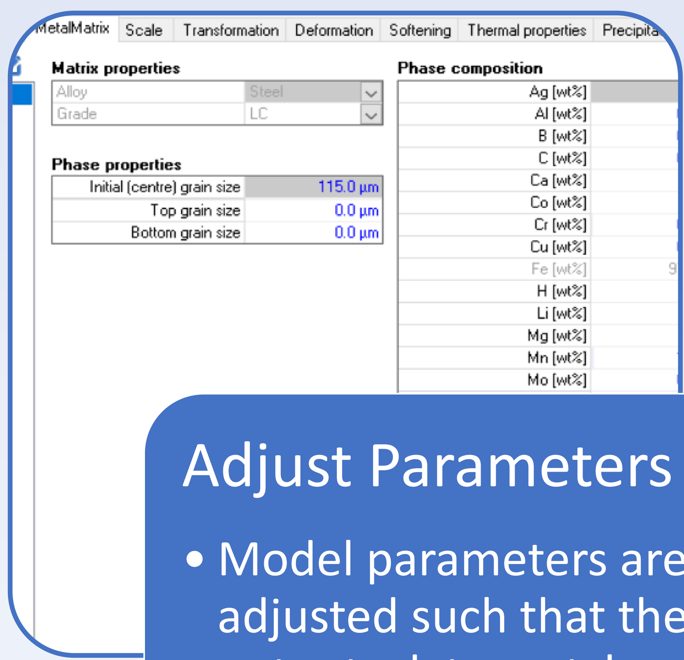
Titan Model

- A preliminary model that reflects the mill geometry, rollers and jets etc. is created.
- Experimentally measured flow rates are also modelled.



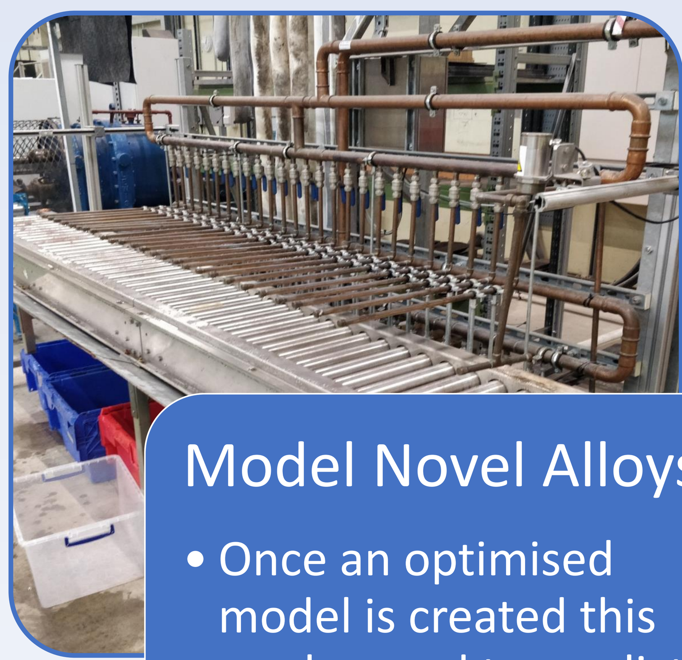
Output Data & Experimental Data

- The microstructural and temperature outputs of the model are compared with the experimental data



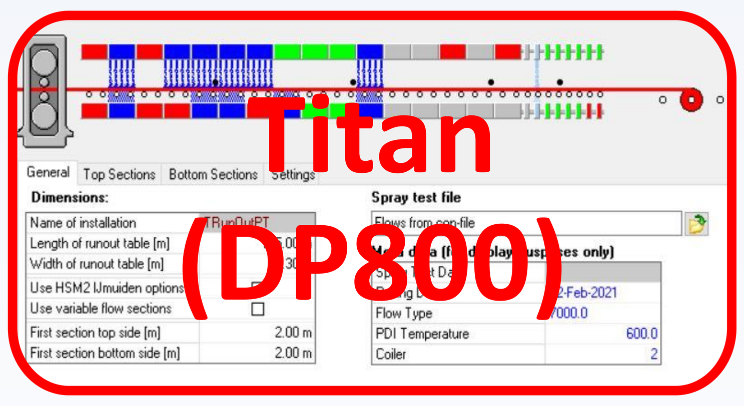
Adjust Parameters

- Model parameters are adjusted such that the outputs data matches the experimental data
- The process is repeated until the model is optimised.



Model Novel Alloys

- Once an optimised model is created this can be used to predict strip behaviour at a smaller scale for novel RAP alloys.



- Optimisation of Titan Model for DP800, modification of cooling paths.
- Better understanding of predicted grain structure.

- Small scale samples created in a scale Run Out Table, alongside Lewis Mill simulation.
- Gain understanding of microstructure at multiple scales.

- Analyse the microstructure, and mechanical strength prior to annealing.
- Compare microstructure at multiple scales to understand effect of sample size.

MAIN IMPACTS OF CURRENT RESEARCH

DECREASED VEHICLE WEIGHT

Decreased vehicle weight results in a direct increase in the range of the vehicle which is one of the known drawbacks regarding electric vehicles. Which is chiefly achieved through the implementation of AHSSs.

INCREASED FORMABILITY

Increased formability allows more freedom for design engineers to create complex geometries improving performance.

RAPID ALLOY PROTOTYPING

All of the work carried out, especially regarding understanding megalographic samples at multiples scales, will feed into the work the Prosperity partnership is doing regarding Rapid Alloy Prototyping, allowing swift implementation of these novel alloys.

Swansea University Prifysgol Abertawe
UKRI Engineering and Physical Sciences Research Council
TATA STEEL
Rapid Alloy Prototyping A PROSPERITY PARTNERSHIP
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