TATA STEEL

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Galvanised Ultra High Strength Steel for Cold Formed Automotive Body In White Applications

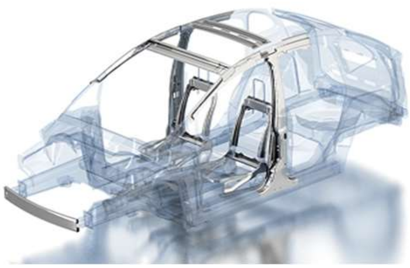

Fig 1 : Automotive body in white
Reference : Tata Steel Europe (2003) *Automotive – Metallic Coated – Advanced and ultra high-strength steel* {Online} Accessed: 03/02/2018

Background

The drive for ever more fuel efficient vehicles has led to the development of a novel range of steels, allowing automotive manufacturers to downgauge on components to not only save weight, but to maintain crash performance of the vehicle. The structural sections of the body in white (BIW) such as the pillars shown in Fig.1 tend to be the most complex and demanding, requiring both high strength combined with good formability. It's these types of products that will be looked at in this project, and will have two main aims:

1) Effects of Silicon on the bake hardening (BH) of dual phase steel
2) Effects of Silicon on the Liquid Metal Embrittlement (LME) of galvanised dual phase steel

Dual Phase Steel

The material in question for this project will be dual phase steel. Dual phase steels combine high strength with good formability, ideal for use in BIW application. These steels have a microstructure that consists of two phases. The ferrite phase, which at room temperature contains a very small amount of carbon, giving a phase with high iron content and therefore good ductility. The main secondary phase is martensite, this is obtained from rapid cooling of austenite, trapping carbon in the matrix leaving a more brittle phase with an increase in strength.

The diagram on the right shows an example of a dual phase microstructure, containing primarily a background matrix of ferrite (white) interspersed with a hard martensite phase (darker region). Two grades that Tata Strip Products UK (TSPUK) currently produce are DP800 and DP1000, meaning 800MPa and 1000MPa tensile strength.

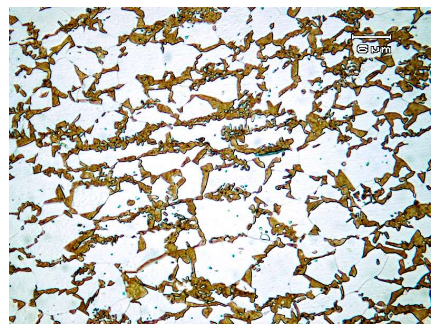

Fig 2 : Dual Phase steel metallography
Reference: De, A K (2003) *Dual Phase Steel Quenched* {Online} Accessed: 08/02/2018)

Project Breakdown and Objectives

Effects of Silicon on the BH of Dual Phase steels

One of the issues that is currently effecting the DP800 product is the bake hardenability. Bake hardening is used to improve the final properties of the material, applying heat to the material during a process such as paint curing. According to the governing steel standard EN 10346, DP800 steels should increase in strength by 30MPa minimum.

The DP800 product struggles to achieve the 30MPa requirement, whilst the DP1000 product of similar chemistry achieves the 30MPa requirement comfortably. Whilst there is a small increase in carbon and manganese in the DP1000 chemistry, the biggest difference is the silicon content, which is considerably higher in the DP800 product.

Investigations at Tata have shown a composition containing purely ferrite and martensite gives a lower BH value, to counter this, the temperature at the end of the cooling has been increased to give a higher increase in bainite proportion, whilst more carbon and manganese have been added to counter the strength loss.

Typically the BH response is influenced by the amount of free carbon in the ferrite, grain size of the material, and dislocation density. All of these were explained as not being the main contributors to the low BH values, so silicon is to be investigated.

Aims and targets:

1) Use vacuum induction melting (VIM) casts containing lower silicon to see effect on properties – 3 casts – 0, 0.25, 0.40wt% Si additions
2) Hot roll, cold roll and anneal as per typical mill requirements
3) Assess all properties of material (hole expansion and bendability)
4) Look at the effect on both cold anneal and galvanised product

Effects of Silicon on the LME of Galvanised Dual Phase steels

Over the last couple of years LME has come to the fore for automotive manufacturers. Present primarily in AHSS and UHSS (>800MPa strength) steels, resistance spot welding (RSW) of these galvanised materials induces cracks into the welding area, particularly around the heat affected zone (HAZ).

This is causing concern for automotive manufacturers incorporating AHSS/UHSS in the production of their new vehicles. The requirements will be to ensure that the materials, when welded, will not have a detrimental effect on the mechanical properties of the component.

A lot of time and effort is being spent on this issue, from steel manufacturers to automotive manufacturers, however with varying test methods for RSW, results can be vary dramatically.

Investigations from several research collaborations have shown that grades with higher levels of silicon are seemingly more sensitive to LME. Keeping a consistent chemistry and varying the silicon content as per the first part of the project requirement means this can be tested to see if differences can be identified.

Another opportunity is to investigate the addition of a new coating at one of Tata UK's site. The coating contains zinc-magnesium, this has been shown in research to also be more sensitive to LME than traditional zinc-aluminium coatings.

Aims and targets:

1) Use VIM casting with varying silicon additions
2) Rolling and coating as per mill requirements – include Zn-Mg coating as variable to see effects
3) RSW / Gleeble testing to see effects of Si content

M2A MATERIALS AND MANUFACTURING ACADEMY

COATED² EPSRC Centre for Doctoral Training in Industrial Functional Coatings

EPSRC Engineering and Physical Sciences Research Council

UNDEB EWROPEAIDD EUROPEAN UNION
Llywodraeth Cymru Welsh Government
Cronfa Gymdeithasol Ewrop European Social Fund