Development of Formable Steel Grades through Alternative Steelmaking Technologies

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TATA
TATA STEEL

Background to project

Steelmaking using an Electric Arc Furnace (EAF) has many environmental benefits compared to the traditional Blast furnace/ Basic oxygen furnace (BF/BOF) steelmaking route, particularly a significant reduction in CO_2 emissions. However, steel made in the EAF route typically has higher carbon and nitrogen levels. Interstitial free (IF) steel requires very low levels of carbon and nitrogen, making it a particular challenge for transitioning to EAF steelmaking. For this reason, the focus of my project is looking at ways to produce IF steel in an EAF.

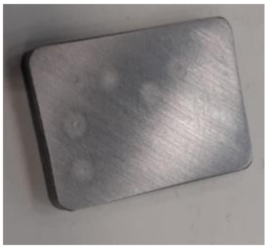
What is the effect of increasing carbon and nitrogen levels on the product performance of formable strip steels?

In order to investigate the effect of different nitrogen levels on properties of the steel such as formability, a method was needed for making IF casts of different nitrogen levels.

Making laboratory casts of different nitrogen content

Casts were made in the 140g centrifugal caster, using electrolytic iron flake with small additions of Mn, Ti, Si and Al. The first cast was made by casting under nitrogen which resulted in a nitrogen content of 19ppm. In later casts, MnN and TiN were added to try and increase the nitrogen content. Key results from this study are given below:

- Casts close to IF composition with different nitrogen content can be created in the 140g centrifugal route using MnN additions, with the amount of N that can be added limited by the target Mn composition. Use of TiN was not effective at adding N to casts.
- Current range of N contents reliably achieved: Low of approx. 9ppm N and high of approx. 60ppm



140g centrifugal cast

InTrap Study

This study aims to investigate the effect of higher nitrogen levels in IF steels by making lab IF casts of fixed excess Ti (0.02 wt%) and different nitrogen levels. Following the InTrap route, the smaller lab scale casts (approx. 100g) were inserted into a larger transfer bar before further processing, allowing processing parameters more representative of those at an industrial scale. The table below summarises the OES/ Eltra results of the casts. These casts were then inserted into an IF transfer bar before hot rolling.

	Fe	C	Mn	Al	Si	S	P	Ti	N eltra (ppm)	Excess Ti (wt%)
Target (wt %)	99.8	0.0019	0.080	0.045	0.004	0.007	0.010			
IF 2.1	99.723	0.004	0.099	0.055	0.003	0.0007	0.0011	0.045	57.3	0.0164
IF 2.3	99.727	0.003	0.095	0.046	0.013	0.0008	0.0015	0.046	47.8	0.0205
IF 2.4	99.739	0.005	0.090	0.044	0.005	0.0009	0.0014	0.040	37	0.0180
IF 2.5	99.68	0.029	0.097	0.048	0.004	0.0013	0.002	0.066	56	0.0369
IF 2.6	99.709	0.004	0.098	0.051	0.002	0.0007	0.0018	0.066	60.3	0.0363
IF 2.7	99.719	0.003	0.101	0.038	0.004	0.0008	0.0015	0.062	35.3	0.0407
IF 2.9	99.707	0.012	0.102	0.048	0.004	0.001	0.002	0.051	37.3	0.0287
IF 2.10	99.72	0.002	0.091	0.046	0.006	0.001	0.0021	0.055	55.7	0.026
IF 2.11	99.68	0.004	0.107	0.061	0.006	0.0009	0.0022	0.062	39.3	0.0392
IF 2.12	99.74	0.002	0.097	0.042	0.004	0.0007	0.0023	0.046	19.7	0.0302

Ti (excess) = Ti – (4C+ 3.42N + 1.5S)

Cylindrical centrifugal cast

InTrap cast – 5 cylindrical casts inserted into 1 transfer bar

InTrap cast after hot rolling

InTrap cast after pickling

Next Steps

- Finish cold rolling/ annealing of InTrap samples, then tensile test to look at the effect of different nitrogen levels on properties
- Plan for making IF casts of different nitrogen contents in the VIM
- Long term: Once the effect of different carbon/ nitrogen contents has been examined in mechanical properties e.g tensile testing, look at impact of adapting processing parameters (e.g soak time, recrystallisation rate, heating rate) on these properties.

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