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Year: Third
Theme: Tata steel packaging
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TATA STEEL

Development of High-Performance Packaging steels

Abstract

This research is looking into the influence of:

- Annealing cycles
- Chemistries

on the mechanical properties of packaging grade steel. There are two chemistries that will be used.

Application

High-strength packaging grade steel with relatively good formability ~5% is very suitable for can ends, particularly for scored easy-open ends (see figure 1a) of canned goods.

Benefits

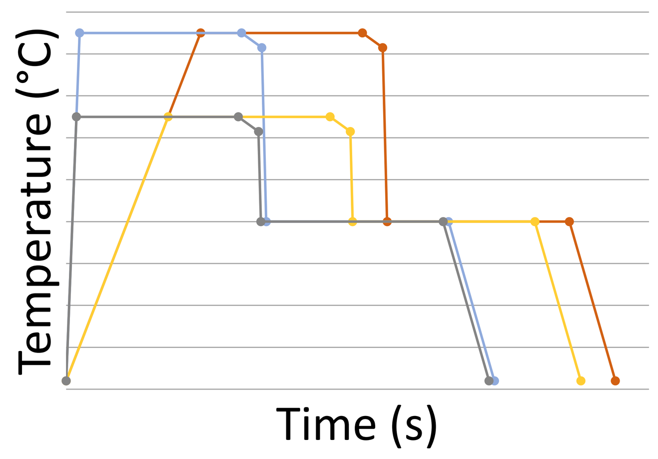
- ✓ Allow downgauging
- ✓ Material savings
- ✓ Cost savings
- ✓ Remain competitive in the market

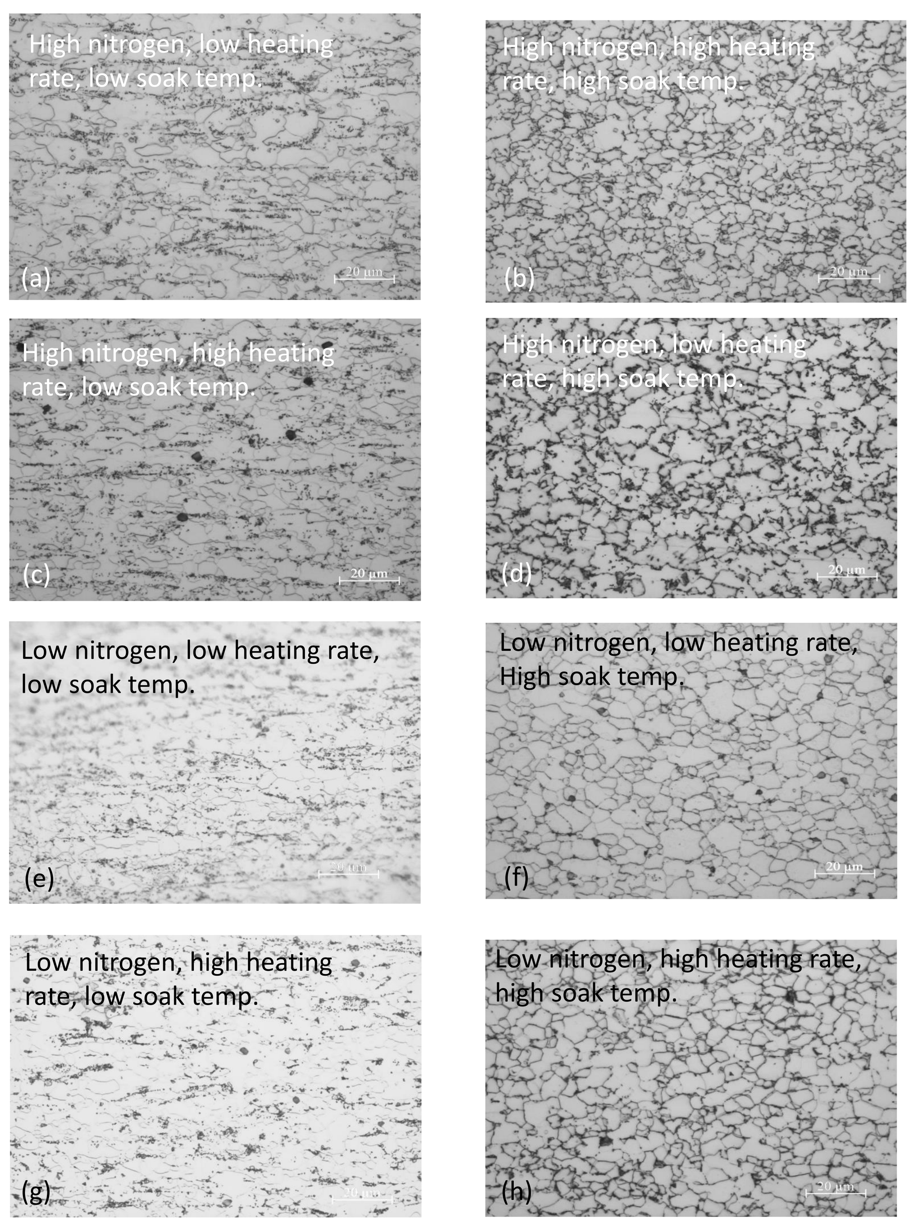
The challenge

The challenge is to produce a stronger packaging grade with the following properties:

- Yield strength (Rp) = 650-750MPa
- Elongation value (A50) = >5% in all directions after a double reduction rolling

Effect of heat treatments on microstructure



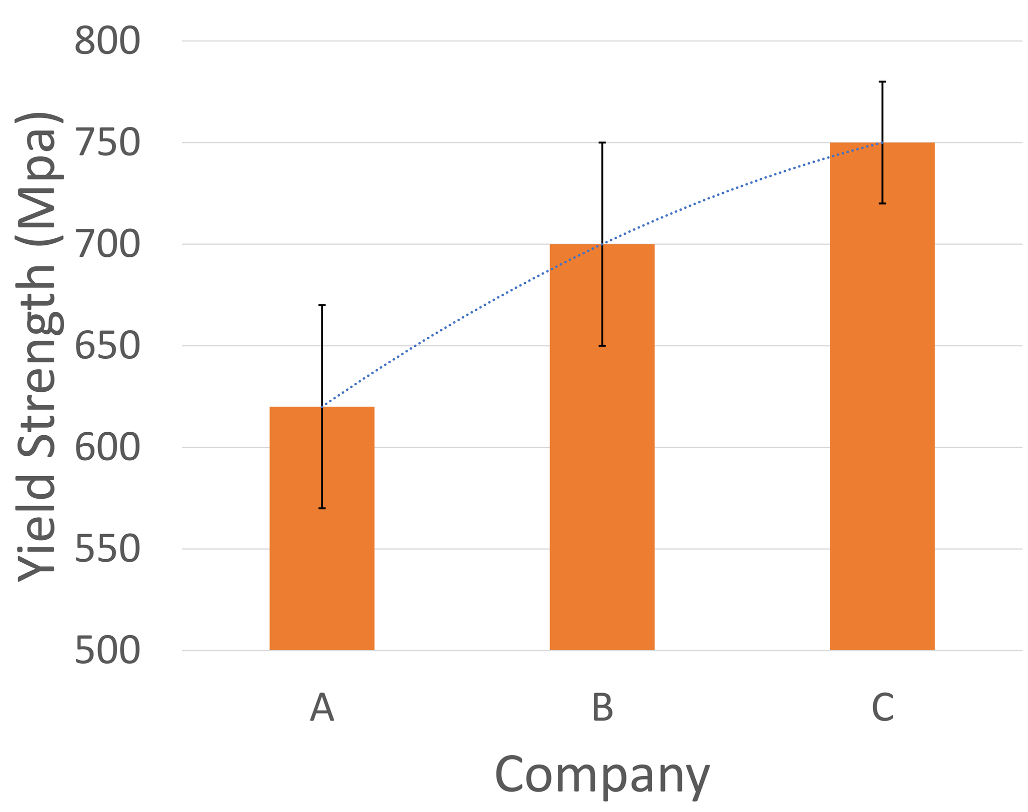


Both grades were subjected to a slow heating to low/high soak temperatures, and a fast heating to low/high soak temperatures. Followed by an over ageing treatment. These heat treatments were conducted using a Gleeble 3500.

Samples annealed at low soak temperatures (images a, c, e, and g) have a slight elongated grain structure after 5%DR. In comparison, samples annealed at high soak temperatures (images b, d, f, and h) result in equiaxed grain structures.

This experiment was performed to see whether any meaningful benefit can be obtained when packaging grade chemistries are subjected to flash annealing.

Reason for project



1. Tata steel packaging (TSP) is seeking a way to manufacture stronger packaging grades of steel as this product is also proposed by competitors.
2. The strongest packaging grade steel TSP make has a yield strength of 620MPa, whereas competitor B and competitor C make grades of 700MPa and 750MPa respectively.
3. To remain competitive in the market, TSP need to develop a packaging grade of steel of equal, or better, mechanical properties than their competitors.

Why these temperatures

Annealing above the Ac1 temperature will result in a recrystallised and a multi-phase microstructure after cooling. Annealing just below the Ac1 temperature (within current production capabilities) will result in a recrystallised microstructure. The effect of both will be compared.

Soak time was kept constant at approximately 1 minute. This reflected a typical time used in a continuous annealing line for high strength packaging steels.

Annealed samples were then subjected to a double reduction (DR) of 5%.

After DR, samples were imaged, and tensile tested to determine:

- Proof strength ($Rp_{0.2}$)
- Tensile strength (Tm)
- Elongation value (At)

The elongation (At) of each sample was measured (see graph on the right) and optical images were taken (See optical images on the left).

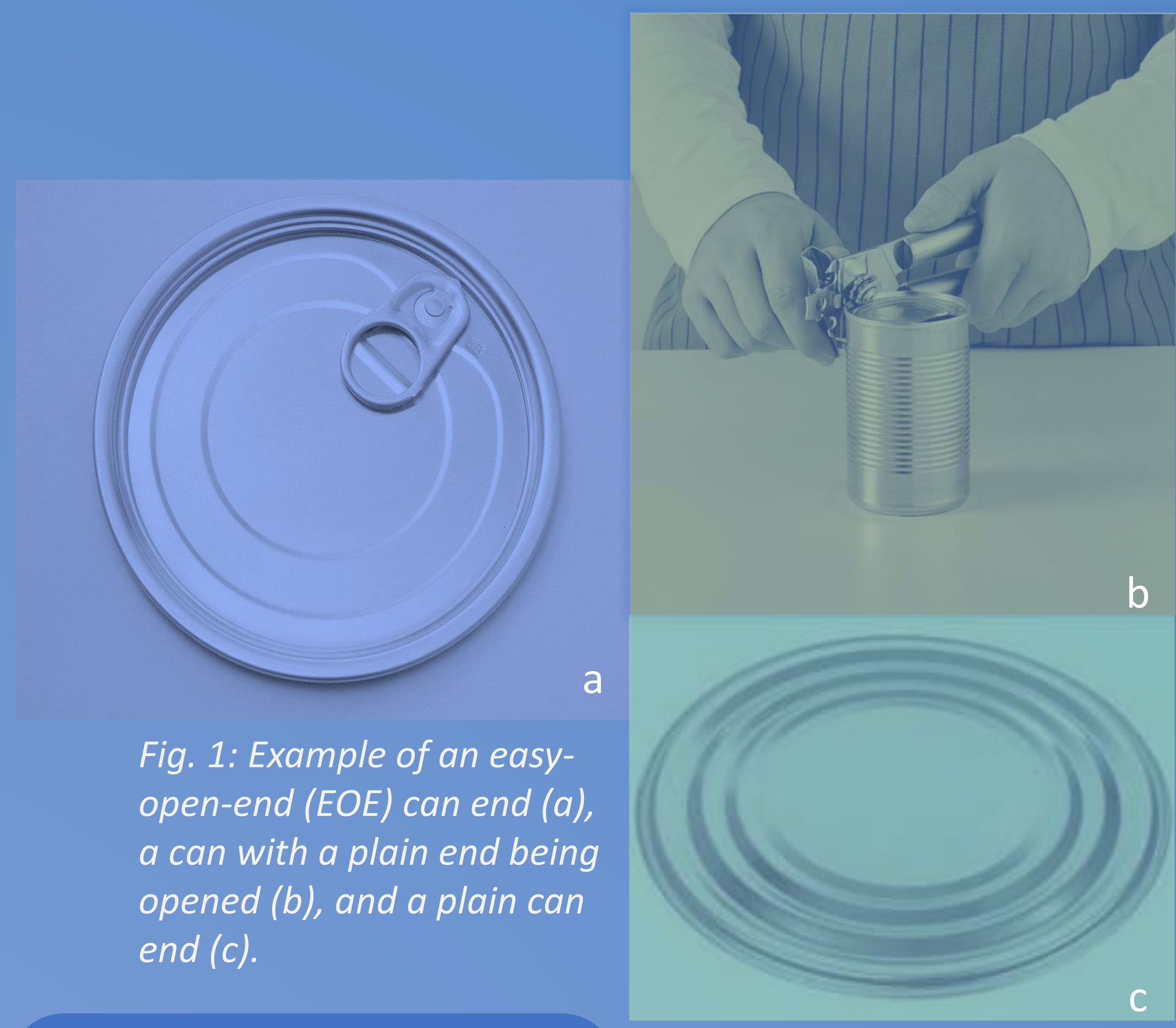
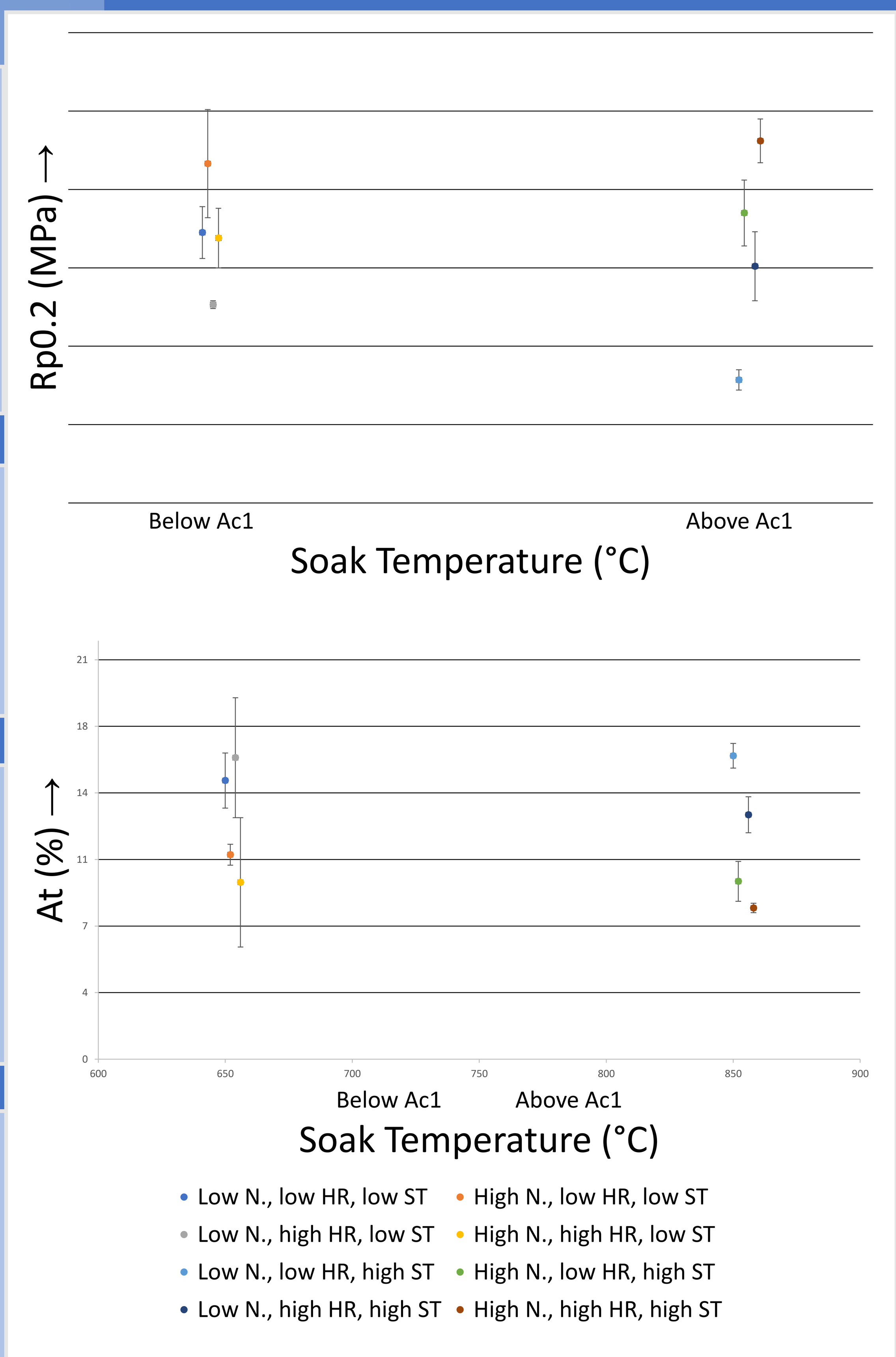


Fig. 1: Example of an easy-open-end (EOE) can end (a), a can with a plain end being opened (b), and a plain can end (c).

The chemistries

A low and high nitrogen grade was lab-casted in Ijmuiden, the Netherlands. The effect of nitrogen on the mechanical properties has been studied.

Effect of heat treatments on Double Reduced properties



Why these heating rates

High heating rate (flash annealing) is chosen because it keeps interstitial elements in solution and provides a greater number of nucleation sites for recrystallisation. More nucleation sites will result in a greater number of grains, which according to the Hall-Petch relationship, a smaller grain size yields greater strength and ductility. A low heating rate is chosen to replicate current production capabilities. The effect of both will be compared.

M2A MATERIALS AND MANUFACTURING ACADEMY

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