Understanding austenite stability in carburised bearing steels

Adriel Wong | Vikram Bedekar | Rohit Voothaluru | Scott Hyde | Enrique Galindo-Nava

#1 Introduction

- Austenite is an important consideration for the performance of multi-phase bearing steels.
- Stable retained austenite (RA) improves fatigue life by altering stress states at localised regions and complicating crack propagation paths.
- However, too much austenite promotes significant material expansion leading to geometric distortions.

#2 What affects RA stability?

- Chemical composition
- RA morphology
- Neighbouring phases
- Austenite grain size
- Grain orientation
- Deformation conditions

#3 Material

<table>
<thead>
<tr>
<th>Alloy</th>
<th>C</th>
<th>Mn</th>
<th>Si</th>
<th>Cr</th>
<th>Ni</th>
<th>Mo</th>
</tr>
</thead>
<tbody>
<tr>
<td>8AC</td>
<td>1.16</td>
<td>0.81</td>
<td>0.25</td>
<td>0.52</td>
<td>0.41</td>
<td>0.20</td>
</tr>
<tr>
<td>4AC</td>
<td>1.14</td>
<td>0.54</td>
<td>0.20</td>
<td>0.48</td>
<td>1.74</td>
<td>0.20</td>
</tr>
</tbody>
</table>

#4 Microstructure

Figure 1: (a) As-carburised; (b) As-quenched

- Contains martensite, RA and carbides.
- Thermal etching reveals prior austenite grain boundaries and a large martensite plate.

#5 Effect of composition

- The stacking fault energy increases with higher C and Ni contents, thus increasing RA stability.
- The steeper slope of the red curve implies that C is a more powerful austenite stabilizer than Ni.
- While alloy 8AC has a higher C content than 4AC, the RA stability in 4AC is higher due to a higher Ni content.

#6 Effect of grain size

- As austenitisation temperature \( T_{\text{aus}} \) increases, the prior austenite grain size (PAGS) increases, but the martensite start temperature \( M_s \) decreases.
- The initial decrease of \( M_s \) with higher PAGS contradicts with reported trends in literature.
- A possible reason is attributed to higher carbide decomposition rates at higher \( T_{\text{aus}} \).
- As C partitions into RA, it becomes more stable and suppresses the \( M_s \) to lower temperatures.

#7 Conclusions

- The results reveal the effect of C and Ni towards the stacking fault energy of austenite in the steels studied, while \( M_s \) and PAGS measurements show conflicting results.
- Preliminary results from the current work can be used to elucidate the influence of chemical composition and austenite grain size towards austenite stability in bearing steels.

Acknowledgements

The financial support provided by The Timken Company in this project is gratefully acknowledged.

Contact Information

- Department of Materials Science and Metallurgy, University of Cambridge, 27 Charles Babbage Rd, Cambridge CB3 0FS.
- Email: atcw2@cam.ac.uk