Low temperature bainite has excellent combination of strength and toughness. A weldable low carbon, low temperature bainite alloy has been examined. Bainite transformation temperature can be decreased as low as 280℃ for steel containing 6 wt % Ni to decrease martensite start temperatures as an alternative of using high carbon.

### Design of Low Carbon, Low Temperature Bainite

- Simple process route avoids rapid cooling so that residual stresses are avoided, even in large pieces.
- Very fine microstructure, mixture of bainitic plates separated by retained austenite film, resulting refinement of the microstructure, which showed a possibility of producing low carbon, low temperature bainite.

### Summary

- **Aim of the Work**
  
  Full martensite hardness should be depressed for low transformation temperatures.

- **Mechanical Properties**
  
<table>
<thead>
<tr>
<th>Alloy</th>
<th>Tensile Strength (MPa)</th>
<th>Impact Energy (J)</th>
<th>% Reduction Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>450 ± 5</td>
<td>44 ± 2</td>
<td>15 ± 2</td>
</tr>
<tr>
<td>B</td>
<td>500 ± 5</td>
<td>48 ± 2</td>
<td>12 ± 1</td>
</tr>
<tr>
<td>C</td>
<td>550 ± 5</td>
<td>60 ± 3</td>
<td>10 ± 1</td>
</tr>
</tbody>
</table>

- **Acceleration of Transformation**

  - Cobalt is accelerating the bainite transformation.
  - Coalesced bainite, same composition with the alloy A without silicon.
  - Silicon suppressed carbide formation, which results in austenite stabilization.
  - Alloy A avoided coalescence with help of silicon which stabilized the residual austenite.
  - The temperature where the fraction becomes zero was not seen because allotriomorphic ferrite starts to form as temperature increases.

- **Residual Austenite**

  - Residual austenite transformed to martensite.
  - Bainite fraction decreases as temperature increases just like the alloy A.
  - Bainite fraction decreases as temperature increases.
  - The temperature where the fraction becomes zero was not seen because allotriomorphic ferrite starts to form as temperature increases.
  - The temperature where the fraction becomes zero was not seen because allotriomorphic ferrite starts to form as temperature increases.

- **Incomplete Reaction**

  - Residual austenite transformed to martensite.
  - Bainite fraction decreases as temperature increases just like the alloy A.
  - The temperature where the fraction becomes zero was not seen because allotriomorphic ferrite starts to form as temperature increases.
  - Incomplete reaction phenomenon.

### Alloy Compositions

<table>
<thead>
<tr>
<th>Alloy</th>
<th>Composition (wt%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Fe - 0.13C - 2.3Mn - 4.0Ni</td>
</tr>
<tr>
<td>B</td>
<td>Fe - 0.13C - 2.3Mn - 4.0Ni</td>
</tr>
<tr>
<td>C</td>
<td>Fe - 0.13C - 2.3Mn - 4.0Ni</td>
</tr>
</tbody>
</table>