G 211

PRIMARY CHILL, CHILLED SPOTS OR EDGES, HARDNESS ANOMALIES

Cast Iron

White iron structure, at least partially, especially in thin sections or at corners and edges, which changes progressively to a normal structure. The transition between the gray and white structure may be very gradual (normal primary chill) or may be discontinuous with white areas in the gray structure and gray areas in the white (mottled).

Cause

The carbon equivalent and/or the carbon/silicon ratio are not correct for the thickness, or cooling rate, of the casting involved.

Remedies

- Inoculate properly and adequately.
- Reduce the cooling rates (for example, eliminate fins which cause fast local freezing).
- Limit and control the content of carbide-forming elements (such as Cr).
- Avoid overheating or prolonged holding of the liquid metal (cause of mottling).

(Examples, following pages)

G 144 - Aluminum Alloy, Die Cast

Aluminum alloy die casting with a hard spot which appeared in relief during polishing.
G 211 - Cast Iron, Combination Shell and Chill Mold

Chilled automotive tappet of gray iron; poured in a shell mold against a drag chill plate.
The iron was melted in a crucible induction furnace.
The end cast against the chill plate shows a normal white iron structure, but there is also an undesired chill spot at the opposite end.

*Cause:* Overheating or prolonged holding of the melt, resulting in disappearance of graphitizing nuclei (fading), and insufficient inoculation to re-establish normal graphitization during cooling.

*Remedy:* Use greater care in controlling charge composition, temperature, additions and sequence of operations.

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Casting section showing the defect.

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G 211 - Cast Iron, Green Sand

Gray iron crankshaft bearing support showing hardness values outside of tolerance.
The hardness measured at the upper left-hand corner of the casting was 241 Bhn, ranging near 220 Bhn elsewhere at the heavier sections.

Casting analysis:

<table>
<thead>
<tr>
<th></th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>3.3</td>
</tr>
<tr>
<td>Si</td>
<td>1.6</td>
</tr>
<tr>
<td>Mn</td>
<td>0.8</td>
</tr>
<tr>
<td>S</td>
<td>0.15</td>
</tr>
<tr>
<td>P</td>
<td>0.20</td>
</tr>
</tbody>
</table>

*Remedy used with success:* Relocate the gating so as to provide more uniform mold temperatures during cooling. In this case, the casting was gated at the hard corner, causing a drop to 230 Bhn without any need to change the composition of the base iron.
G 211 - Cast Iron, Green Sand

Gray iron casting with chilled edges caused by low carbon equivalent, and especially by too low a carbon content. The relatively large area of chill could not be eliminated simply by ferrosilicon inoculation.

Figure 257

G 212

UNMOTTLED CHILL, CLEAR CHILL

Cast iron.

Zones with a white iron structure, especially in thin sections, at edges or corners, or near fins. Contrary to defect G 211, transition from the white to the gray structure occurs abruptly.

Possible Cause
Where the causes given for defect G 211 cannot be found to blame, it is usually a matter of excessively high sulfur/manganese ratio in the iron.

Remedies
Clear chill is not always a defect. On the contrary, it is sought in certain applications such as rolling mill rolls. Among other factors it is favored by a high S/Mn ratio.

For complete elimination of the chilled zone, with or without transition, see remedies for G 211.
G 213

INVERSE CHILL

Cast iron.

The edges surrounding the fractured surface show a normal gray iron structure, whereas the interior sections may be entirely white without transition, show only small white areas, or may be largely mottled.

Possible Causes
— Excessive S/Mn ratio.
— High hydrogen content.
— High titanium content in combination with low sulfur.

Remedies
— Reduce sulfur content; desulfurize if necessary. Neutralize the sulfur with manganese (Mn should exceed 1.75 x %S + 0.3).
— Provide proper superheating and inoculation.
— Reduce hydrogen content by using well preheated ladles. Dry the molds.

G 213 - Cast Iron, Green Sand

Figure 258
(right)

Samples prepared in six different foundries, all showing characteristic inverse chill. For each case, as shown in the analyses below, the S/Mn ratio is high:

<table>
<thead>
<tr>
<th></th>
<th>C</th>
<th>Si</th>
<th>Mn</th>
<th>S</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>2.75</td>
<td>2.77</td>
<td>0.23</td>
<td>0.074</td>
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<td>3.09</td>
<td>2.76</td>
<td>0.36</td>
<td>0.102</td>
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<tr>
<td>c</td>
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<td>2.11</td>
<td>0.33</td>
<td>0.080</td>
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<td>d</td>
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<td>2.27</td>
<td>0.28</td>
<td>0.104</td>
<td>1.97</td>
</tr>
<tr>
<td>e</td>
<td>2.90</td>
<td>2.34</td>
<td>0.34</td>
<td>0.140</td>
<td>1.66</td>
</tr>
<tr>
<td>f</td>
<td>3.11</td>
<td>2.08</td>
<td>0.28</td>
<td>0.180</td>
<td>1.42</td>
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