MICROSTRUCTURE EVOLUTION AND MECHANICAL PROPERTIES OF COLD DRAWN HYPEREUTECTOID STEEL WIRE

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ABSTRACT

Microstructure evolution of hypereutectoid steel wire during the drawing process was studied by SEM, TEM, XRD and VSM, respectively. The results show the cementite in the hypereutectoid steel shows good deform ability. With the drawing strain increased, the pearlitic colonies gradually aligned to the drawing direction. Moreover, partial dissolution of cementite caused by cold deformation was observed, and the quantitative tests show that dissolution of cementite increased in correspondence with the increase in strain. The increase of lattice constant in ferrite matrix, a slight left shift in the ferrite diffraction peaks were due to carbon atoms dissolved into ferrite crystal. Mechanical properties of steel wire with different strain was measured, and the main strengthening mechanism was discussed. In the initial stages of drawing, the strengthening of pearlite steel may be accorded with Hall-Petch relationship.

Keywords: cold deformation, microstructure, mechanical properties, cementite dissolution, strengthening mechanism.

INTRODUCTION

Implementation of policy for EU tire labeling law EC661/2009 and EC1222/2009 puts forward higher requirement for low rolling resistance tire. The empirical study proves that it is beneficial to reduce the tire of rolling resistance tire by increasing the strength of the steel cord as reinforcing material in tire. Recent investigations for development on steel cord is mainly on pearlitic steels in which the content of C is less than 0.8%, however, few researches on hypereutectoid steel is reported. Cold drawing is an effective process to increase the strength of fully pearlitic steels with an acceptable level of ductility. Once the carbon in pearlitic steel dissolved during the drawing process occurred, materials performance would change greatly. So the strength and ductility of steel wire is mainly controlled by the solution strengthening due to carbon dissolved.

In this work, microstructure evolution and mechanical properties of hypereutectoid steel wire during the drawing process is the emphases of research and a model accounting for the cementite dissolution is proposed and the strengthening mechanism is also established based on experiments.

RESULTS AND CONCLUSIONS

The results from the VSM tests are shown in Fig. 1. The increase of lattice constant in ferrite matrix, a slight left shift in the ferrite diffraction peaks were due to carbon atoms dissolved into ferrite crystal. Table 1 shows the results that dissolution of cementite increased in
correspondence with the increase in strain. Fig.2 shows the mechanical properties of steel wire with different strain. The strengthening of pearlitic steel may be accorded with Hall-Petch relationship.

Table 1 - Content of cementite with different strain in steel wire

<table>
<thead>
<tr>
<th>Strain (ε)</th>
<th>Saturation magnetization (μemu/g)</th>
<th>Content of cementite (vol.%)</th>
<th>Dissolution of cementite (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>200.57</td>
<td>14.1</td>
<td>7.1</td>
</tr>
<tr>
<td>0.54</td>
<td>202.89</td>
<td>13.1</td>
<td>7.1</td>
</tr>
<tr>
<td>1.58</td>
<td>206.67</td>
<td>11.5</td>
<td>18.4</td>
</tr>
<tr>
<td>2.29</td>
<td>208.52</td>
<td>10.7</td>
<td>24.1</td>
</tr>
</tbody>
</table>

This study shows that microstructure evolution and mechanical properties of hypereutectoid steel wire during the drawing process is the emphases of research and a model accounting for the cementite dissolution is proposed and the strengthening mechanism is also established based on experiments.

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REFERENCES