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Development of Cast Steel Brake Disc with Heat Shock Resistance

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Recently, the maximum running speed of railway cars and braking load continues to increase leading to the need to improve the heat shock resistance of railway cars discs. In this study, the heat shock resistance of two materials with different hardenability was compared in the braking tests. In discs with good hardenabilty, hardness near the friction surface was increased and many cracks were observed. The white layer was clarified to be martensite. On the other hand, in discs with poor hardenabilty, hardness hardly changed and the heat shock resistance was good. The white layer was clarified to be tempered martensite.

Keywords: *cast steel, brake disc, heat shock resistance, heat crack, hardenability.*

1. Introduction

Recently, the running speed of railway car has become fast and the load to the brake disc has increased. It is said that the transformed phase so called white layer has something relations to crack initiation not only in the brake disc but also in a wheel and rail[1-3], however the relation between the microstructure and the crack resistant has not been clarified yet.

In this study, discs with two materials which have different hardenabilities (G: good hardenability and P: poor hardenability) were subjected to braking tests and the heat cracks and the white layer on the friction surface were observed by OM and TEM to investigate the relation between crack resistance and microstructure change.

2. Experimental Procedure

2.1 Manufacturing the discs

Brake discs whose chemical compositions were shown in Table 1. were melted in RF furnace and cast into the sand mold. Thereafter the discs were heat-treated (1223K×3h Annealing, 1233K×3h Water Quenching, and 903K×3h Temperig) and were machine worked.

Table 1 Chemical compositions of discs with different hardenabilities (mass %).

Material	C	Si	Mn	Ni	Cr	Mo	Al
G	0.23	0.80	0.80	1.70	0.80	0.50	0.03
P	0.23	0.80	0.50	0.50	0.80	0.80	0.03

2.2Braking test and microstructure observation

Brake discs were subjected to braking-test assuming Shinkansen equivalent conditions: maximum running speed is 300km/h)

Following the braking test, the discs were cut and microstructures near friction surfaces were observed by OM, and hardness changes were measured by Vickers hardness tester (Hv0.10).

White layers confirmed by OM were observed by TEM in particular.

3 Results and Discussion

3.1 OM observation and hardness distribution

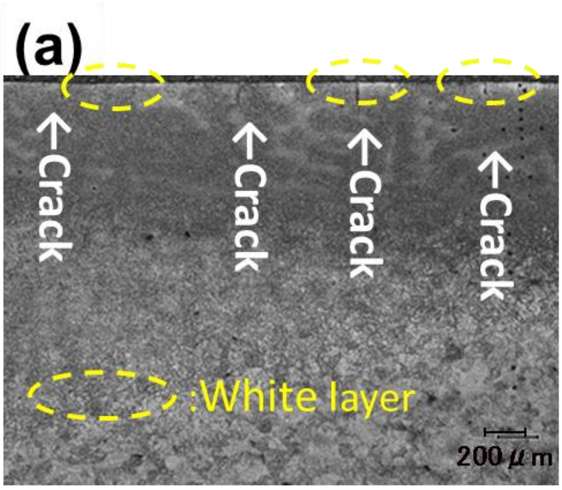
Fig.1 shows the microstructures observed by OM and Fig.2 shows the hardness distribution near friction surface.

OM observations clarified that both discs have white layer and heat cracks. However hardness near the friction surface of good hardenability disc has increased than that of poor hardenability.

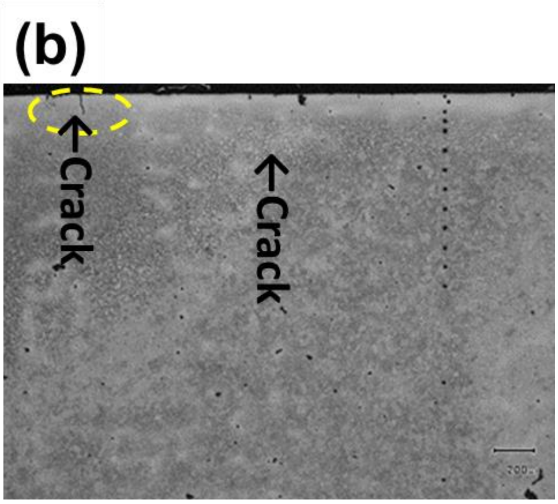
3.2 TEM observation

Fig.3 shows the micrograph observed by TEM.

White layer with good hardenability disc was fresh martensite with high density dislocation. On the other hand, acicular cementite precipitation has confirmed in white layer with poor hardenability disc. The material of poor hardenability has less Mn content than the material of good hardenability, and it is considered that it is easily tempered in the material of poor hardenability.



(a) Good hardenability disc



(b) Poor hardenability disc

Fig.1 Microstructures observed by OM.

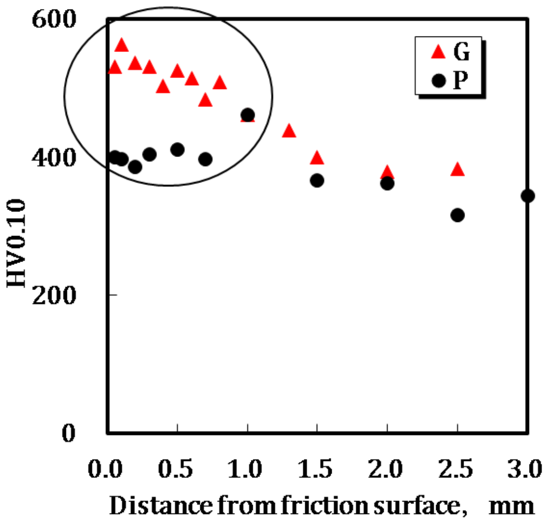
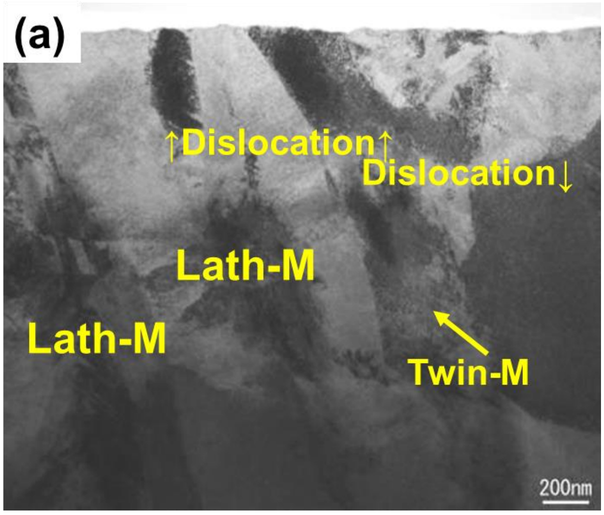
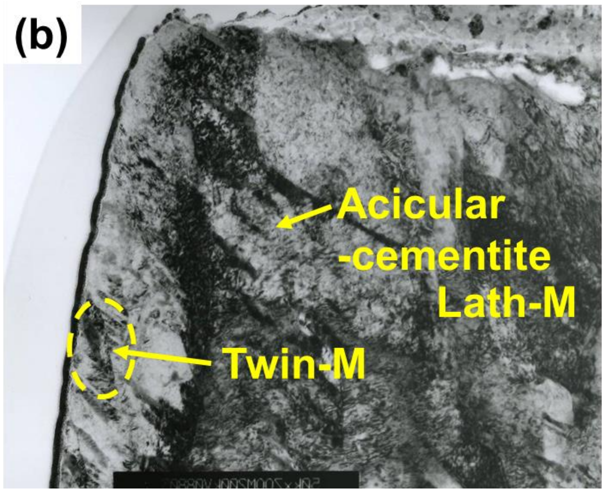


Fig.2 Hardness distribution near friction surface.



(a) Good hardenability disc



(b) Poor hardenability disc

Fig.3 TEM images of white layer observed by TEM.

4. Conclusions

(1) Heat shock resistance of disc has correlate strongly with its hardenability.

(2) White layers were observed in both discs regardless of their hardenabilities.

(3) White layers of disc with good hardenability were lath-martensite including high-density dislocations, the others were lath-martensite with acicular cementite because of less content of Mn.

References

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