KAWASAKI STEEL TECHNICAL REPORT
No.1 (September 1980)

Effects of Alloying Elements and Cooling Rate after Annealing on Mechanical Properties of Dual Phase Sheet Steel

Koichi Hashiguchi, Minoru Nishida, Toshiyuki Kato, Tomoo Tanaka

Synopsis :
For the purpose of producing a highly formable dual phase steel by intercritical annealing, the effects of alloying elements and cooling rates on microstructure and properties have been studied. The effect of alloying elements on the critical cooling rate (CR) required for the formation of dual phase structure are representable equivalent manganese content (Mneq): log CR(/s)=-1.73Mneq(%)+3.95 Where Mneq(%)=Mn(%)+2.67Mo(%)+1.3Cr(%) When gas-cooled, a 1.2% Mn-0.5%Cr steel exhibits a low yield strength of 20kg/mm2 and a low yield-to-tensile strength ratio as low as 0.4. Without causing solid solution hardening and a decrease in dissolved C content in ferrite, Cr reduces the yield strength of ferrite, resulting in the lowering of the yield strength of dual phase structure.

KAWASAKI STEEL TECHNICAL REPORT No. 1 September 1980

Effects of Alloying Elements and Cooling Rate after Annealing on Mechanical Properties of Dual Phase Sheet Steel*

Toshiyuki KATO** Tomoo TANAKA**

For the purpose of producing a highly formable dual phase steel by intercritical anneal-

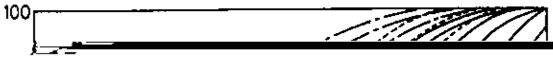
critical cooling rate can be predicted from CCT curve during cooling from α−γ range. The ...

be 770 °C in $\alpha-\gamma$ range at which the fraction of γ ...

lated the CCT curves for steels with various chemical compositions and investigated the relationship between the alloy content and the critical cooling rate. The authors also conducted experiments on various ...

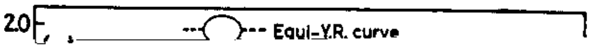
in the range of 0.1–1 000 °C/s (taking the experiment described later into consideration). The decomposition of γ phase during cooling is calculated on the assumption that C content in α grain is 0.5 % and ...

kinds of steel to confirm the calculated ...

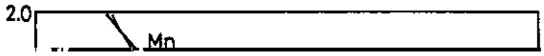


$$Mn^{C}_{eq}(\%) = Mn(\%) + 3.28Mo(\%)$$

materials. Tensile testing was performed in th



150 °C/s for 25 kg/mm² and 30 kg/mm², respectively.



remains in α phase in as-cooled condition. This over-
saturated C is decreased by ageing at 170 °C.

must, however, be emphasized that because of the complicated influence of alloying elements and the ... Q^{-1} is difficult to correctly

measure solute C content from Q^{-1}. It can be con-

cluded from the calculation and measured Q^{-1} values

increase in Mn content. This fact clearly shows that aging proceeds at room temperature in specimens as-

precipitated at the room temperature, as reported by

K. Tsunoyama, et al.[11]. The ageing at room temperathe Ms temperature is lowered and the temperature

As described above, the yield strength of dual phase high alloy steels associated with adequate cooling rate. As shown in **Figs. 6** to **8**, however, there is an optimum combination of chemical composition and cooling rate and better tensile properties are obtained only when a higher alloy steel is cooled neither too slowly nor too rapidly. High alloy steels are also less

[redacted]

cooling rate. When the 0.05 %C–1.2 %Mn–0.5 %Cr steel is cooled at the rate of 30 °C/s, a low yield strength of 20 kg/mm^2, a yield ratio as low as 0.4 and

[redacted]

a low yield strength of 20 kg/mm^2 and a yield-to-tensile strength ratio as low as 0.4.

(4) The addition of Cr is favorable since it decreases the dissolved C content by promoting the partition of C between austenite and ferrite, while it does not cause solid solution hardening in

[redacted]

References

1) N. Ohashi, I. Takahashi and K. Hashiguchi: Trans. ISIJ, **18** (1968), p. 321

[redacted]