

半熔融Cr-V-Mo鋼の組織と機械的性質に及ぼすRAP方法の影響

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Introduction

Recrystallization and Partial Melting (RAP) method was invented by Kirkwood et al. to fabricate billets with a fine-grained spherical microstructure in the semi-solid state. In our research, the feasibility of RAP route to refine cast SKD61 steel was investigated experimentally. Meanwhile the development of microstructure and mechanical properties of cast SKD61 during RAP processing were checked. Based on the experimental result, two kinds of innovative route to fabricate tool steel products was invented. Compared with the conventional route, our innovative routes are more energy-efficient and more time-saving.

Experiment

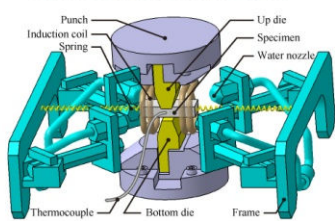
Material

As cast SKD61 steel was used. The solidus temperature and liquidus temperature of SKD61 are 1318 and 1489°C respectively.

Schematic diagram of experimental setup

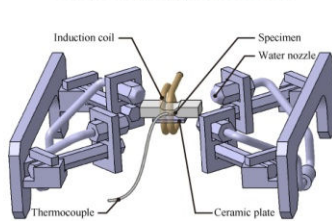
Predeformation experiment

Equipment:
Multistage hot compression test machine;
Test temperature: 300°C;
Strain rate: 1/s
Reduction rate: 50%
Cooling method: Water cooling.



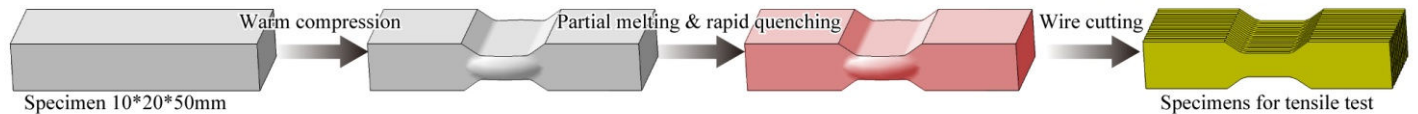
Partial melting experiment

Equipment:
Multistage hot compression test machine;
Heat temperature: 1385°C;
Cooling method: Water cooling.



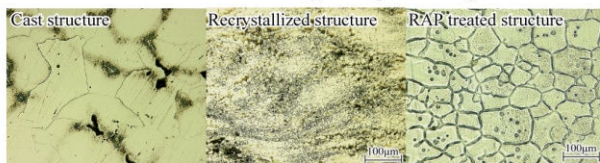
Tensile test

Equipment:
Simazu Tensile test machine;
Test temperature: Room temperature;
Tensile speed: 1mm/s.

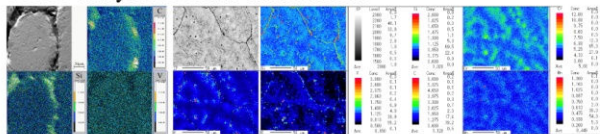


Results

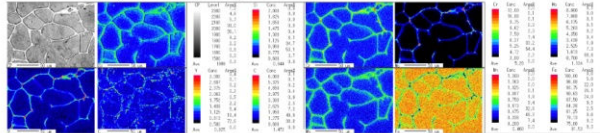
Microstructural evolution during RAP processing



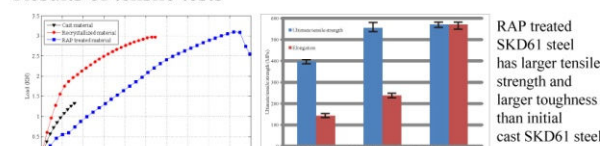
EBSD analysis of initial cast material



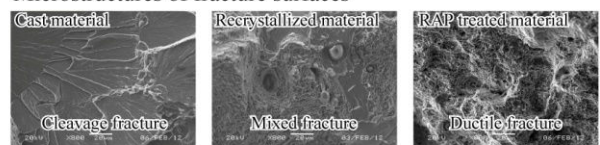
EBSD analysis of RAP processed material



Results of tensile tests

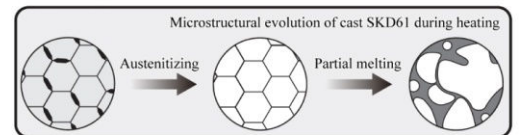


Microstructures of fracture surfaces

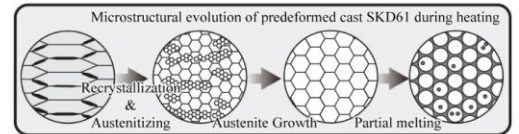


Schematic illustration of microstructural evolution of cast Cr-V-Mo steel

1. Without predeformation:
Austenitization + Partial melting



2. With predeformation:
Recrystallization + Austenitization + Growth of austenite grains + Partial melting



Schematic illustration of conventional route and innovative routes:

Innovative route A: RAP + Hot Forming; Innovative route B: RAP + SSF.

