論文 / 著書情報
Article / Book Information

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著者(和文)	LuoZichao
Author(English)	Zichao Luo
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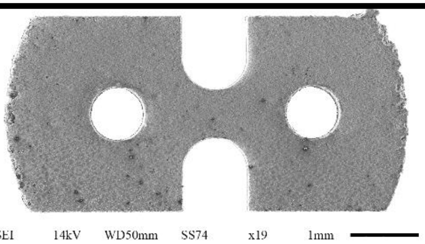
学位種別(和文)	博士論文
Category(English)	Doctoral Thesis
種別(和文)	要約
Type(English)	Outline

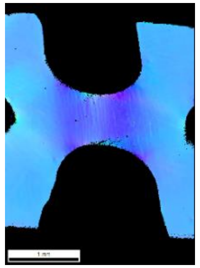
Study on deformed texture

Microstructural evolution during tensile deforming studied with CP-FEM and EBSD

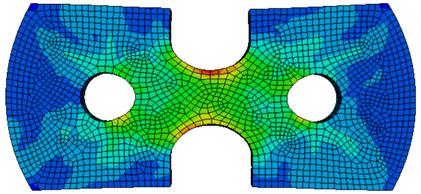
Tensile test on single crystal iron specimen



Derive texture information by EBSD



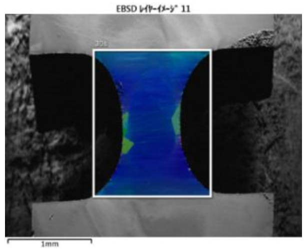
Crystal plasticity finite element simulation with measured initial microstructure



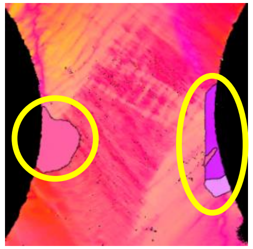
Study on nucleation site

Prediction of nucleation sites with different parameters

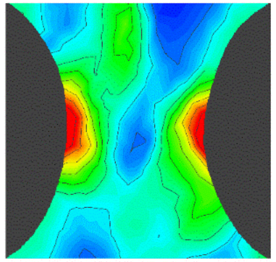
In-situ EBSD observation on static recrystallization



Determine approximate nucleation sites



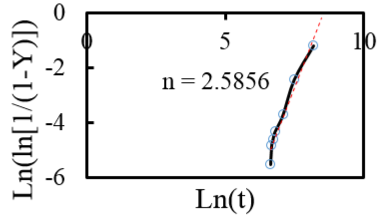
Prediction of nucleation positions with calculated KAM



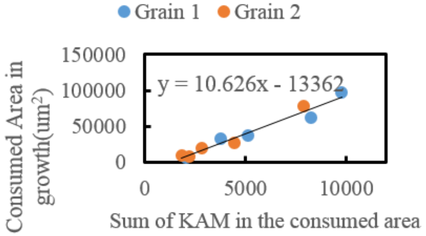
Study on grain growth

Grain boundary migration observation with in-situ EBSD and modelling the grain growth

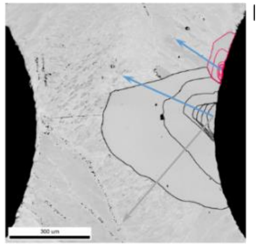
Modelling overall kinetics



Single grain growth vs KAM



Modelling boundary migration velocity



Summary of main conclusions:

- CP-FEM model which can reproduce the deformed characteristics has been developed;
- KAM value calculated from CP-FEM delivers an effective mesoscale representation of local deformation and can qualitatively predict nucleation positions.
- Cellular automaton model was built to simulate grain growth based on EBSD data. Relative roles of curvature related energy and stored deformation energy were studied: the former takes effect in regularizing grain boundary shape to reduce boundary energy; and the later would generate protrusions toward highly deformed matrix and is the main driving force of boundary migration.

Outline of thesis

The following list describes the outline of this thesis:

CHAPTER 1: Introduction

In this chapter, the relationship between microstructure of metal materials and their physical properties is introduced. Two methods to modify microstructure of metals, namely alloying and TMCP are covered. The merits of TMCP over alloying are underlined and current problems regarding to the application of TMCP are briefly reviewed. Study on the evolution of microstructure in TMCP can be decomposed into three subtopics: deformed microstructure, nucleation and grain growth.

CHAPTER 2: Literature review

This chapter follows the reasoning in Chapter 1 and is devoted into literature review on the aforementioned three topics: deformed microstructure, nucleation and grain growth. Both experimental approaches and numerical studies are covered.

CHAPTER 3 – Experimental and numerical study of deformed microstructure

This chapter describes the methodology used for the current study, including details about experimental setting and CP-FEM simulation setting. The former subsection covers specimen fabrication, tensile deforming and in-situ EBSD observation. The latter is mainly about fundamental theories of CP-FEM, boundary conditions of current model and optimization method for the derivation of hardening parameters. After these two subsections, the direct comparison between experiments and simulations is made to evaluate the model.

CHAPTER 4 – Prediction of nucleation sites

In this chapter, fist the approximate nucleation sites were derived from in-situ observations. Then the comparison between experimentally derived KAM and calculated KAM is made. Based on the derived quantities, nucleation rules from literature are tested.

CHAPTER 5 – Grain growth in recrystallization

This chapter mainly describe observations and modelling on grain growth during recrystallization. Starting from in-situ observation results, grain growth kinetics are discussed and qualitative discussions are made on both single grain kinetics and the change of grain boundary morphology during grain growth. Grain growth is modeled with cellular automaton based on orientation information derived from EBSD observation.

CHAPTER 6: Conclusions

This final chapter of this thesis describes the concluding summary of the research project.

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