【Grant-in-Aid for Scientific Research (S)】

Science and Engineering (Engineering)

Title of Project : Modeling of solidification dynamics supported by 3D time-resolved in-situ observations

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Research Project Number : 17H06155 Researcher Number : 60239762
Research Area : Materials Science, Solidification Processing
Keyword : Melting/Solidification, Casting, Crystal growth/Fabrication

【Purpose and Background of the Research】

The control of solidification structures and the reduction of solidification defects are critical issues for improving the materials properties. Difficulties with observing solidification phenomena *in-situ* for metallic alloys, particularly those with high melting temperatures, have led to ambiguities in under-standing the solidification process. Recently, our group has developed 2D time-resolved *in-situ* observation techniques (using transmission images) at SPring-8 addressing some of these ambiguities. Further advances are possible with 3D time-resolved *in-situ* observation (4D-CT) and these will assist in the development and verification of quantitative models.

In this project, 4D-CT techniques for observing solidification will be developed using X-ray imaging techniques developed by our group and using the advanced photon source at SPring-8. 4D-CT is applied to observe solidification phenomena. Fundamentals and previously unobtainable knowledge relating to the solidification process and the formation of casting defects will be obtained using these methods.

【Research Methods】

[A] Development of 4D-CT

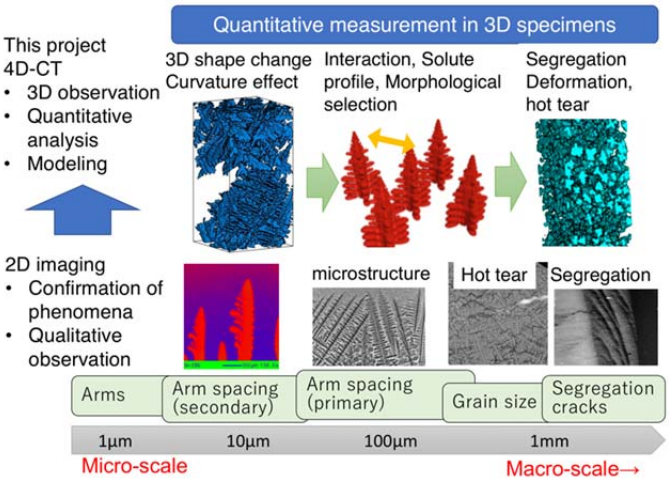
A 4D-CT technique will be developed for observing the evolution of solidification structure in metallic alloys. Expected spatial resolutions are 10μm for fast CT (period: 2s) and 1μm for high resolution CT (10s), respectively.

[B] 3D time-resolved in-situ observation

4D-CT observations will be performed for solidification of metallic alloys. For example, observation of 3D configuration and crystallographic orientation of solid grains in the semisolid state will help in understanding semisolid deformation, which is valuable for predicting casting defects.

[C] Quantitative modeling and simulation

Solidification models considering curvature effects and the configuration of solid grains will be constructed for predicting solidification structure and defects. In addition, computational materials science will be used for understanding experimental results.



【Expected Research Achievements and Scientific Significance】

New knowledge for understanding the solidification process will be obtained by the 4D-CT observations. The knowledge will contribute to the development of reliable models, which will be validated by the observations. The models will allow a greater degree of microstructure control during typical commercial solidification processes.

【Publications Relevant to the Project】

・M.A.A. Mohd Salleh, C. M. Gourlay, J. W. Xian, S. Belyakov, H. Yasuda, S. McDonald, K. Nogita, Sci Rep, 7 (2017) 40010.
・K. Yamane, H. Yasuda, A. Sugiyama, T. Nagira, M. Yoshiya, K. Morishita, K. Uesugi, A. Takeuchi, Y. Suzuki, Metall Mater Trans A, 46A (2015) 4937.
・T. Nagira et al, Metall Mater Trans A, 45A (2014) 1415.

【Term of Project】 FY2017-2021

【Budget Allocation】 130,200 Thousand Yen

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