# Multi-phase-field-lattice Boltzmann model for polycrystalline solidification with melt convection

**Tomohiro Takaki[a], Roberto Rojas[b], Shinji Sakane[c], Munekazu Ohno[d] and Yasushi Shibuta[e]**

[a] Faculty of Mechanical Engineering, Kyoto Institute of Technology
Matsugasaki, Sakyo-ku, Kyoto 606-8585, Japan
e-mail: takaki@kit.ac.jp, web page: http://www.cis.kit.ac.jp/~takaki/index-e.html

[b] Department of Mechanical Engineering, Escuela Politecnica Nacional
Ladron de Guevara E11-253, 17-01-2759 Quito, Ecuador
Email: rcrmroberto_rojas@hotmail.com

[c] Graduate School of Science and Technology, Kyoto Institute of Technology
Matsugasaki, Sakyo-ku, Kyoto 606-8585, Japan
e-mail: m5623012@edu.kit.ac.jp, web page: http://www.cmd.kit.ac.jp/

[d] Division of Materials Science and Engineering, Faculty of Engineering, Hokkaido University
Kita 13 Nishi 8, Kita-ku, Sapporo 060-8628, Japan
e-mail: mohno@eng.hokudai.ac.jp, web page: http://labs.eng.hokudai.ac.jp/labo/LSC/english/

[e] Department of Materials Engineering, The University of Tokyo
7-3-1 Hongo, Bunkyo-ku, Tokyo 113-8656, Japan
e-mail: shibuta@material.t.u-tokyo.ac.jp, web page: http://www.mse.t.u-tokyo.ac.jp/

## ABSTRACT

It is crucial for a material design to accurately predict the material microstructure formed during solidification. However, a numerical prediction of the solidification microstructure is difficult, because the solidification is a complicated multi-physics problem including the solid-liquid phase transformation, crystal anisotropy, solute diffusion, thermal conductivity, melt convection, solid motion, grain growth and so on.

In this study, we develop a multi-phase-field-lattice Boltzmann model to express a polycrystalline solidification with melt convection. This model can simulate the growth, motion and collision of multiple dendrites in the presence of melt convection and the grain growth after collision between different dendrites. This is attained by extending a phase-field-lattice Boltzmann model for a single dendrite [1, 2] to the multiple dendrites expressed by the multi-phase-field model. Some two-dimensional simulations are demonstrated to express the ability of the developed model.

## REFERENCES

[1] R. Rojas, T. Takaki, M. Ohno. “A phase-field-lattice Boltzmann method for modeling motion and growth of a dendrite for binary alloy solidification in the presence of melt convection”, *Journal of Computational Physics*, Vol. **298**, pp. 29–40, (2015).

[2] T. Takaki, R. Rojas, M. Ohno, T. Shimokawabe, T. Aoki “GPU phase-field lattice Boltzmann simulations of growth and motion of a binary alloy dendrite”, *IOP Conference Series: Materials Science and Engineering*, Vol. **84**, 012066, (2015).