A Combined Multi-Phase-Field/Discrete-Element Method for Sintering of Blended Elemental Powders

Kazunari Shinagawa
Kyushu University
Fukuoka, JAPAN

ABSTRACT

As a method for producing alloy parts by powder metallurgy, blended elemental powder processing has been developed to attain cost-saving and reducing forming load. It can also be used to fabricate heterogeneous materials, which may result in enhanced strength and toughness. The formation of heterogeneous microstructure, however, is affected by the size, the amount, and the distribution of the elemental powder particles, and they should be controlled to obtain the optimized mechanical properties. In this study, a method for simulating the diffusion of elements and the phase transformation during sintering is proposed. As a model system, a binary eutectic alloy is assumed, and the interdiffusion and the liquid formation between different two particles are simulated by a multi-phase-field method for sintering. The discrete-element method is also conducted to compute the sintering shrinkage with taking account of the contact area and the sintering force, obtained from the phase-field.

INTRODUCTION

In the application of the powder metallurgy technique for the fabrication of micro devices or composite materials, mesoscopic behaviour of powder particles during sintering should be figured out to control the final shape and microstructure of the sintered body. To simulate the motion of each particles during sintering, the discrete element method (DEM) has been developed for sintering process[1, 2]. The author proposed a method for simulating sintering shrinkage as well as grain growth by coupling DEM with the phase-field method[3]. These methods were applied to the solid state sintering of single phase only. To produce alloy parts, there are two common approaches, using blended elemental and pre-alloyed powders.