ABSTRACT
Semi-solid casting (SSC) of magnesium alloys is increasingly being used to produce high-quality components. Using this process, higher strength, thinner wall sections and tighter tolerances without porosity are obtained. High-precision fabrication of thin-walled components with large surface areas is possible. They are widely used for the IT, auto and consumer electronics industries. However, warpage of the thin-walled Mg alloy parts, the geometry of gating system affecting quality of the product should be thoroughly studied. In this paper, to minimize warpage of the thin-walled sections, Taguchi method is applied to the optimal design of the gate geometry in the thixomolding process. Width, height, length and angle of the gating system are selected for the robust design parameters. Effectiveness of the robust design is verified through the CAE software.

Key Words: Gate system, Mg alloy, Semi-solid casting, Taguchi method, Thixomolding, Warpage

INTRODUCTION
Magnesium has excellent electromagnetic interference (EMI) shielding, good damping, high specific strength characteristics. It is widely used for the IT, auto and consumer electronics industries [1,2]. In general, Mg parts have been produced through the die casting process. Recently there is increasing demand to apply semi-solid casting (SSC) of Mg alloys for manufacturing of high performance components. This process is similar to the injection molding of plastics with very high pressure and is called thixomolding. It is strictly governed by thixotropic property of injected semi-solid slurry. Using this process, higher strength, thinner wall sections and tighter tolerances without porosity are obtained. High specific strength characteristics of magnesium alloys render high-precision fabrication of thin-walled components with large surface areas. However, warpage of the thin-walled section degrade quality of the part produced in the SCC process. To understand the thixomolding process of AZ91D Mg alloy parts, mechanical properties and dimensional accuracy of the thixomolding process were studied in the previous work [3]. As the microstructure of thixomolding product consists of spheroidal particles compared with dendrites of conventional casting product, and the injection pressure is much greater than that of the die casting process, SSC manufactures high-integral and low-porous products. It produces better mechanical property than what is achievable by the conventional liquid metal die casting process. However, there is difficulty for maintaining coexistence of liquid and solid in the thixomolding process. An inadequate set of process parameters causes high porosity and unequal cooling in the thixomolding. Also, it causes deformation of products [3,4]. In the previous study, optimal parameters of injection velocity, die temperature, barrel temperature, and so on affecting the quality of the finished products were studied when the gate system had been specified by an expert [3].

In addition to the previous study, inadequate geometry of the gating system generates turbulent flow and cavity during the SSC process. Irregular cooling deforms the product as well [5]. For the better product quality the geometry of gate system of the SSC mold should be studied thoroughly. In this paper, Taguchi method is applied for optimal design of the gate geometry in the thixomolding process when the operating parameters are fixed to the previously obtained optimal values of injection speed, barrel temperature and mold temperature [3]. Optimal width, height, length and angle of the gating system are studied for the robust design parameters. Effectiveness of the robust design is confirmed through the CAE system, AnyCasting [6].