Title: Die design method for thin plates by indirect rheo-casting process and effect of die cavity friction and punch speed on microstructures and mechanical properties

Author: Chul Kyu Jin Chang Hyun Jang Chung Gil Kang

PII: S0924-0136(15)00202-2
DOI: http://dx.doi.org/doi:10.1016/j.jmatprotec.2015.05.002
Reference: PROTEC 14407

To appear in: *Journal of Materials Processing Technology*

Received date: 12-11-2014
Revised date: 28-4-2015
Accepted date: 1-5-2015

Please cite this article as: Jin, C.K., Jang, C.H., Kang, C.G.,Die design method for thin plates by indirect rheo-casting process and effect of die cavity friction and punch speed on microstructures and mechanical properties, *Journal of Materials Processing Technology* (2015), http://dx.doi.org/10.1016/j.jmatprotec.2015.05.002

Die design method for thin plates by indirect rheo-casting process and effect of die cavity friction and punch speed on microstructures and mechanical properties

Chul Kyu Jin[1], Chang Hyun Jang[1], Chung Gil Kang[2,*]

[1] Precision Manufacturing System Division, Graduate School, Pusan National University, San 30 Chang Jun-dong, Geum Jung-Gu, Busan 609-735, South Korea

[2,*] Engineering Research Center for Net Shape and Die Manufacturing, School of Mechanical Engineering, Pusan National University, San 30 Chang Jun-dong, Geum Jung-Gu, Busan 609-735, South Korea

E-mail: cgkang@pusan.ac.kr

Abstract

Thin plates with a thickness of 1.2 mm are fabricated from semi-solid A356 alloy through an indirect rheo-casting process both with and without an electromagnetic stirrer (EMS). The thin die cavity for forming is designed with the fluid analysis software MAGMA. A semi-solid slurry with a solid fraction of 40% is prepared and then injected into the die of a 200 ton hydraulic press. Forming tests are performed on the thin plates at two punch speeds (30 and 300 mm/s) and two cavity friction conditions (m_f = 0.4 and m_f = 0.9). The formability, mechanical properties, and microstructure are then evaluated. The semi-solid slurry obtained with an EMS contains fine and globular solid particles; the semi-solid slurry produced without an EMS reveals rosette particles and coarser globular solid particles. At high friction (m_f = 0.9), the cavity is mainly filled with the liquid phase. At a higher punch rate, the thin plates show better formability and a microstructure with fine and even solid particles. The tensile strength and elongation of the thin plate formed with a punch speed of 300 mm/s in the cavity with graphite lubrication (m_f = 0.9) are 216 MPa and 10%, respectively. These values are 57 MPa and 5.5% higher, respectively, than those of the thin plate formed at a punch speed of 30 mm/s.

Keywords: Semi-solid slurry, Indirect rheo-casting, Electromagnetic stirring, Thin plate, Filling simulation, A356 alloy