Fluidity and Mechanical Properties of Open Cell AZ31 Mg Alloy Foam

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Abstract

발포금속은 초경량 재료로서 폐기공과 개기공의 두 가지 형태의 구조를 지니고 있으며 폐기공은 내층경절, 충돌성, 단열성의 기능을 지니고 있고, 개기공은 필터, 생체지지대, 축력제, 열방출제 등으로 사용되고 있다. 개기공발포제는 삼차원 구조모양으로 프리커서를 이용한 압력밀봉주조나 기공질융합법으로 제조하고 있으나 기공의 크기나 패의 형상, 두께 등

을 조절하기에 어려움이 있다. 이를 해결하기 위하여 환경친화적인 블라이트를 사용하여 목적하는 크기의 그레들을 제조한 후, 용융아크접합법을 사용주조법으로 주조하여 그레들의 크기로 기공품을 조절하고, 주형의 온도와 압력에 따른 유동의 급리를 측정하였다. 그레는 직경이 2.3 mm의 일때에 주형의 온도300°C 이상, 압력이 5000 Pa 이상에서 유동길이6.5 cm 이상을 얻었다.

Key words: Open-cell foam, Metal foam, Mg alloy, Gravity casting method, Infiltration, Fluidity.

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1. Introduction

Metal foam is revolutionary materials that exhibit different attractive characteristics when compared to their solid material counterparts [1]. The pores can be sealed (closed-cell foam), or they can form an interconnected network (open-cell foam). Open-cell metal foam is a new class of materials with low densities and novel physical, mechanical, thermal, electrical, and acoustic properties [2,3]. They offer potential for thermal management, catalyst support, filtration, steam generation, energy absorption, acoustic absorption, and filters. Al and Al alloy foams have been developed successfully and have been employed in the new generation of crash boxes. Mg and Mg alloy foams are densely expected to be particularly advantageous due to lower densities of their metal matrix, which are approximately two thirds of Al and good mechanical properties [4,5]. Many methods for their manufacture, characterization and application are being developed [6,7]. In this research, we used investment casting method. It was simple and low cost to cast by vacuum pump.

A. Jinnapat and A. Kennedy studied on open cell Al foams made by infiltration molten al into porous salt [8]. M. Grohn and C. Hintz, investigated determination of parameters of infiltrated metallic foam composites. The open cell structure reticulated polyurethane foams were used [9]. I. N. Orbulov, Á. Németh and J. Dobránszky carried out composite production made by pressure infiltration. Open cell foams, syntactic foams and carbon fiber reinforced metal matrix composites were produced by pressure infiltration method [10]. Fluidity is an important factor for the successful production of castings, and yet the study on the fluidity of open cell AZ31 Mg alloy foam is empty in the world [11].

So in the present work, experiments were performed in order to determine the importance of parameters on fluidity of open cell AZ31 alloy metal foam. The influence of characteristic was investigated along with the influence of vacuum assistance and the preheat temperatures of mould. The mechanical properties and energy absorption were investigated and discussed.

2. Experimental procedure

2.1 Prepare Granular

Fig. 1 shows the standard sieve was used to get similar size the granule. Plaster powder, perlite powder, Polyvinyl Alcohol (PVA), spherical sugar or salt particles were raw material to
manufacture the granule. The granule making process: (1) Plaster and perlite powder were adequately mixed as ratio of 1:1 by rolling mixing machine. They are averaged to mix for 12 hours. (2) Weighing 500 ml water, heating to 100°C added 20 g Polyvinyl Alcohol (PVA), boiling 1 hour. An aqueous solution containing Polyvinyl Alcohol (PVA) was about 4% as binder. (3) The balling chamber rotation speed kept on 1.7-3.5 rpm at angle $\angle 25^\circ - \angle 45^\circ$. The plaster powder, the perlite powder, the salt particle gradually become the granule with sprayed the 4% PVA binder. (4) Dried the granule at the 100°C drying box.

2.2 Fabricate open cell AZ31 Mg alloy foam

AZ31 Mg alloy ingot was used as a metal matrix. The chemical compositions of the AZ31 alloy listed in Table 1.

Fig. 2 shows a set of fabrication apparatus for making AZ31 open cell Mg alloy foam. It mainly consists of two resistance furnaces. one furnace is melting the magnesium alloy, the other furnace is preheated the granule mould, a steel crucible, a stopper in the upper furnace which is switch for the molten Mg alloy into the bottom furnace and a gas system supplies the protecting gas to the upper furnace and the lower furnace. The preparation process is as follows: (1) A definite quantity of AZ31 Mg alloy was melted in a steel crucible in the upper furnace. (2) Prepared the porous leachable bead performs. A various sizes of granule were arrangement in the granule mold. The pore shape was predominantly controlled by the initial shape of the space-holder granules. (3) The molten

<table>
<thead>
<tr>
<th>Element</th>
<th>Al</th>
<th>Zn</th>
<th>Mn</th>
<th>Si</th>
<th>Cu</th>
<th>Fe</th>
<th>Mg</th>
</tr>
</thead>
<tbody>
<tr>
<td>AZ31</td>
<td>3.49</td>
<td>0.82</td>
<td>0.41</td>
<td>0.07</td>
<td>0.08</td>
<td>0.06</td>
<td>Bal</td>
</tr>
</tbody>
</table>

*ICP Mass Spectrometer Machine

Fig. 2. Schematic diagram of apparatus for making open cell Mg alloy foams.