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Mg-Cu-Y BULK METALLIC GLASS SYNTHESIZED VIA SPRAY FORMING

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ABSTRACT

Mg-based bulk metallic glasses (BMG) exhibit maximum specific strength among bulk metallic glass systems. In this study, Mg65Cu25Y10 bulk metallic glass (BMG) was synthesized successfully via spray forming with rapid solidification rate and much higher cooling rate than conventional routes. The microstructure and constituent composition of the Mg65Cu25Y10 BMG were measured by DSC, XRD, and SEM equipped with EDS. All the four characteristic temperatures, Tg, Tx, Tm and Tl, of the BMG were obtained from continuous-heating DSC. The glass forming ability of the Mg65Cu25Y10 BMG was determined. The incubation time of the crystallization of as-injection cast BMG was obtained by isothermal DSC, and the appropriate temperature range in supercooled region for plastic deformation was determined.

Keywords: bulk metallic glass, glass forming ability, spray forming, MgCuY.

INTRODUCTION

Spray-forming is a novel process feasible for fabricating BMGs. It has rapid solidification rate and fast cooling rate, while offering an unlimited dimension growth through controlled semisolid liquid layer at the growing top surface. In this study, an Mg65Cu25Y10 BMG plate was successfully produced. As spray forming began, molten metal was atomized with high pressure N2 into droplets and then collected onto a liquid nitrogen forced-cooled copper substrate to form a deposit of 300mm in diameter, 10mm in maximum thickness, and 650 g in weight.

RESULTS AND CONCLUSIONS

X-ray diffraction patterns were obtained from various positions (1mm, 5mm, 9mm from free surface) of spray-formed plate, compared with that from as-melt-spun ribbon. The characteristic amorphous-like broad peaks are shown at angles of 20-40° for all spray-formed and melt-spun specimens. The identical XRD results obtained from the three positions also demonstrate that the spray-formed plate is completely amorphous.

DSC traces for the spray-formed plate and melt-spun ribbon at heating rate of 40K/min is shown in Fig. 1, in which glass transition temperature (Tg) and crystallization temperature (Tx) are marked. Table 1 summarizes the results of DSC. Based on XRD and DSC, the glass forming abilities (GFA) of the spray-forming specimens, γ, are comparable to that of the melt-spun one.

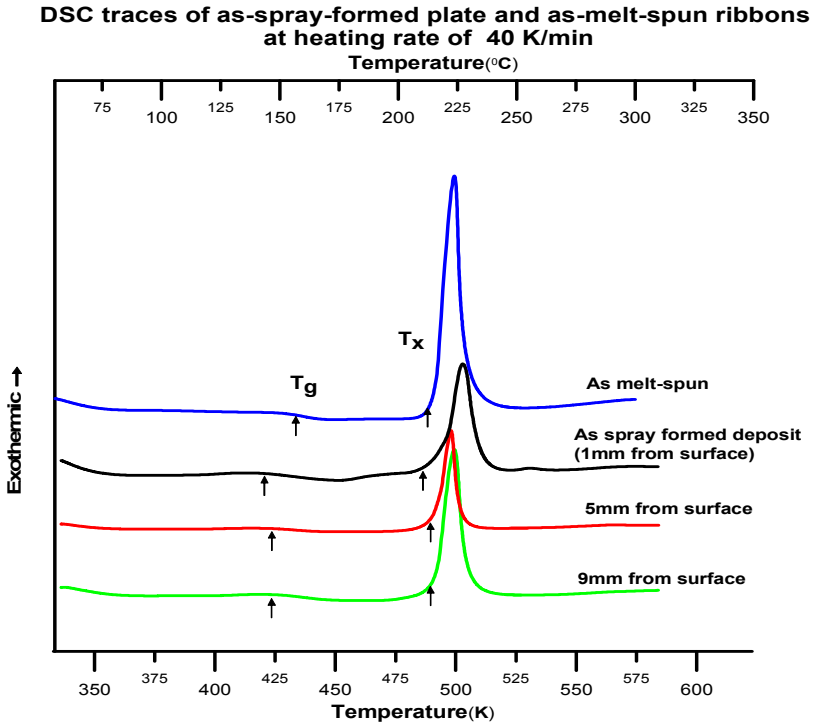

Fig. 1 - DSC traces for the spray-formed plate and melt-spun ribbon at heating rate of 40K/min

Table 1 - Thermal properties of as-spray-formed deposit and as-melt-spun ribbons obtained from DSC at heating rate of 40 K/min (0.67 K/sec)

	T_g (K)	T_x (K)	ΔT_x	T_l (K)	T_{rg}	γ
As-melt spun ribbons	428	489	61	760	0.563	0.412
As-spray formed deposit (1mm from surface)	415	486	71	759	0.547	0.414
As-spray formed deposit (5 mm from surface)	421	491	70	764	0.551	0.414
As-spray formed deposit (9 mm from surface)	424	493	69	760	0.557	0.416
$Mg_{65}Cu_{25}Y_{10}$[5]	425	486	61	771	0.551	0.406

TEM images of the spray-formed plate and melt-spun ribbon were obtained. Ring patterns and non-crystalline images of spray-formed plate from various positions and from melt spun ribbon indicate fully amorphous phases for the Mg65Cu25Y10 BMG plate.

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