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Microstructure and micro-mechanical behaviors of bulk amorphous alloy prepared by spark plasma sintering

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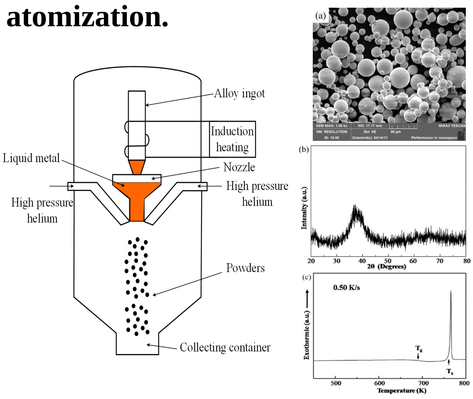
Introduction

- Bulk amorphous alloys were prepared by SPS technology at two different temperatures, which were lower than and higher than the glass transition temperature (T_g) separately.
- The nanoindentation behavior of the prepared bulk amorphous alloy and the relationship between the nanoindentation behavior and the sintering process and microstructure were studied.
- The effect of T_s and the bonding zone on the micromechanical behavior of the sintered bulk amorphous alloys was also discussed.

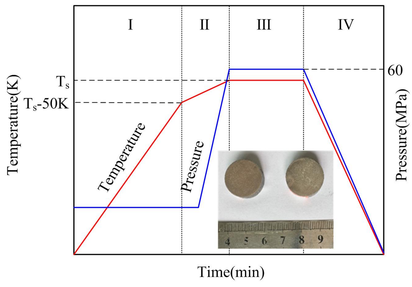
Materials

The amorphous alloy powders with a nominal composition of $Zr_{55}Cu_{30}Al_{10}Ni_5$ prepared by gas atomization.

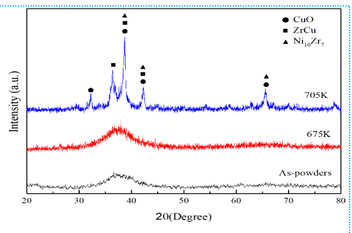


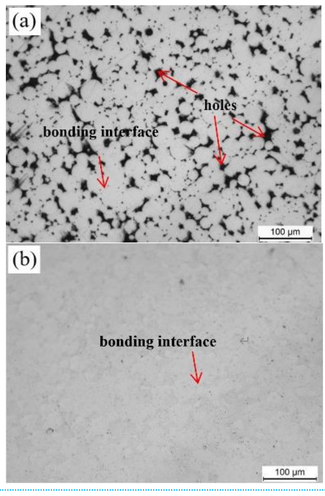
Methods

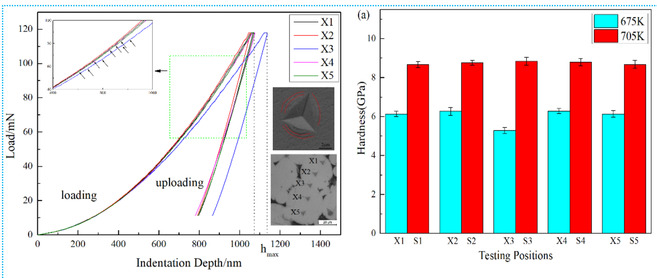
The raw amorphous powders were sintered in a vacuum using the SPS-331lx sintering equipment. Two temperatures near T_g were selected as the T_s, which were 675K and 705K.

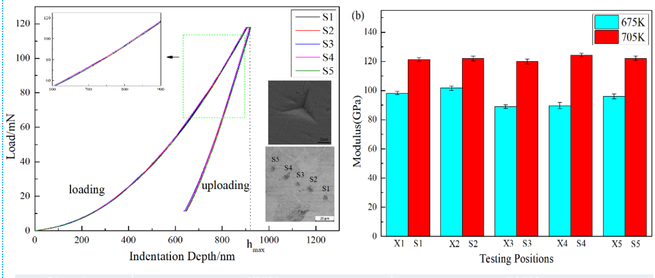


Results









Sintering temperature	675K			705K		
Testing positions	Hardness H_n(GPa)	Modulus E(GPa)	h_{max} (nm)	Hardness H_n (GPa)	Modulus E (GPa)	h_{max} (nm)
X1(S1)	6.130	98.220	1063.007	8.666	121.242	918.346
X2(S2)	6.262	101.682	1051.144	8.755	121.961	915.68
X3(S3)	5.291	89.037	1135.167	8.836	120.066	917.051
X4(S4)	6.282	89.590	1073.070	8.795	124.308	912.500
X5(S5)	6.134	95.950	1068.509	8.678	122.03	919.378

Conclusions

- Under the combined action of electric field, temperature, and pressure of the SPS sintering process, the edge of powder particles melted to form the sintering neck, and bulk amorphous alloy with a higher degree of amorphization was obtained finally.
- Obvious shear bands and “pop-in” were noted in the nanoindentations in the interior of the particles and at the junction of the metallurgically bonded particles of the bulk amorphous alloy at 675K. The hardness and modulus of the bulk amorphous at 705K were uniform and relatively.

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