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ABSTRACT

Vickers micro-hardness indentations, tension and notch toughness tests, as well as controlled strain experiments via bending over mandrels of different diameter have been performed on two different compositions of Fe-based (Fe-Si-B) metallic glass ribbons. Vickers microhardnesses of 1020 +/- 125 and 1045 +/- 20 were obtained on Fe78Cu9B13 for the air side and wheel side, respectively. The Fe78Cu9B13 exhibited 910 +/- 40, respectively. Tensile strengths of the Fe78Cu9B13 were 2000 MPa +/- 100 and 1640 MPa +/- 35 for Fe78B13, consistent with the difference in micro-hardness, although somewhat less than the strength predicted from micro-hardness. The notch toughnesses were similar (e.g. 89 +/- 0.9 MPam1/2 for the former, 94.5 +/- 5.5 MPam1/2 for the latter) although the lower strength ribbon was consistently tougher despite its lower micro-hardness and tensile strengths. SEM examination of notch toughness fracture surfaces revealed some differences in fractography between these samples. The fracture toughness measurements and the estimated compressive strengths and the estimated compressive strengths. The microhardness measurements and the estimated compressive strengths. The microhardness measurements and the estimated compressive strengths. The microhardness measurements and the estimated compressive strengths.

INTRODUCTION

Common Crystal Structures – Exhibit Long Range Order

Anomalous Metal Structure – No Long Range Order

MATERIALS & METHODS

Two different compositions of Fe-based amorphous ribbons were produced via melt spinning using a chilled copper rotating wheel. The resulting ribbons were 20 mm width and had a thickness of approximately 50 μm and 38 μm for the Tough Ribbon and Brittle Ribbon respectively. The chemistries of two ribbon were Fe78Cu9B13 and Fe73.5Cu1Nb3Si13.5B9 at. %, for the Tough and Brittle Ribbons, respectively.

RESULTS SUMMARY

1- Microhardness Tests

- MEHAHLER micro-hardness tester with a load of 200 g

2- Uniaxial Tensile Testing

- Instron Model 1125 universal testing machine: initial strain rate 10^-3 s^-1

3- Notch Toughness Testing

- The notch was placed using a slow speed diamond impregnated wire saw with a rock radius of 110 μm

- Hourglass shape Tension specimens with Kt = 1.25 were used

4- Bending over Mandrels Tests

- Band over mandrel tests were conducted on both batches of ribbon.

- Mandrel diameter of 19.05 mm.

- The samples were sequentially bent over smaller diameter mandrels until permanent deformation or fracture occurred.

- The controlled strain : $\varepsilon = \frac{\rho}{\varphi^*} \text{, where } \varphi = \text{ribbon thickness, } \rho = \text{mandrel radius}$

- The corresponding stress $\sigma = E \cdot \varepsilon \text{, where } E = \text{modulus of elasticity}$

- Mandrel Dia, mm Strain Stress, MPa Strain Stress, MPa

Brittle Ribbon Tough Ribbon

19.05 0.002 219 0.0016 173
12.7 0.003 329 0.0024 260
5.6 0.0058 746 0.0094 589

1.98 0.02 (*) 2111 (*) 0.0152 1667
1.19 X X 0.0252 2773
0.50 X X 0.5029 8560 (Y)

(*) Fracture of the Brittle Ribbon Sample
(+) Permanent Deformation of the Tough Ribbon Sample

CONCLUSIONS

- The composition of the Ribbon has a Significant Effect on the Mechanical Properties as well as the fracture morphology of the Ribbon.

- SEM examination of notch toughness fracture surfaces revealed some differences in fractography between these two batches of Ribbon.

FUTURE WORK

- Evaluate the Mechanical Properties ofRibbons at Elevated Temperatures
- Study the Effects of annealing on the Mechanical Properties of Ribbons.

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