Mechanical Properties of Al-based Amorphous Alloy Ribbons

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ABSTRACT

A well-balanced combination of strength and density is a necessary requirement for structural materials. Significant interest has arisen in amorphous aluminum alloys in recent years because of their high strength and light weight. The deformation behavior of Al-based amorphous alloys was characterized. A series of Al-based ribbons were produced via the melt spinning technique. High temperature microhardness indentation and uniaxial tensile tests were conducted over a range of temperatures to investigate the effects of changes in test temperature and chemical composition on the mechanical properties of these ribbons. Fatigue properties have been characterized via a fatigue ductility test. Furthermore, microstructural evolution and fracture surfaces were analyzed by a variety of analytical techniques, including X-ray diffraction, differential scanning calorimetry, and scanning electron microscopy.

DESIRED PROPERTIES FOR STRUCTURAL MATERIALS

- High strength
- Low density
- Good formability

MATERIALS

Al-RE-TM system amorphous alloy ribbons (at%):
- Al86Gd6Ni7Fe1
- Al86Gd6Ni7Fe1Co1
- Al85Gd6Ni7Co1
- Al86Gd6Ni7Co1
- Al85Gd6Ni7Fe1Co1

MATERIALS TEST CONDITIONS

- Specimen geometry:
  - RT, 100℃, 200℃
  - Strain rate = 5 × 10⁻⁴ sec⁻¹
  - Gauge length/radius = k = 5

HIGH TEMPERATURE MICROHARDNESS

- As received specimens
- Very high bend ductility was observed

HIGH TEMPERATURE TENSILE TEST

- Test conditions:
  - RT, 100℃, 200℃
  - Heating rate = 3K/min
  - Specimen geometry:
    - Width = 0.9mm
  - Strain rate = 5 × 10⁻⁴ sec⁻¹

DEFORMATION BEHAVIOR OF AMORPHOUS ALLOYS

- Inhomogeneous flow:
  - At temperature sufficiently below Tg
  - Localized strain
  - Shear bands formation
  - Catastrophic failure

- Homogeneous flow:
  - At temperature around Tg
  - Uniform deformation

EXAMINATION OF FRACTURE SURFACES

Al47Gd48Ni4Co1 deformed at RT, 100℃
- Specimens failed immediately after yielding
- Specimens failed in shear
- Vein fracture morphology

Al47Gd48Ni4Co1 deformed at 200℃ under
- Very high true fracture strain (> 20%)
- Reduced in area ~ 50%
- Ductile rupture

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REFERENCES


Vickers Hardness Number (kg/mm²)

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<th>Temperature °C</th>
<th>VHN at RT</th>
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<th>VHN at 200℃</th>
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Cyclic Strain Range, %

10 9 8 7 6 5 4 3 2 1 0

Nf, Cycles to Failure

100 1000 10000 100000 1000000 10000000

Specimen for tensile testing

Fatigue limit was reached below a strain range of 0.78%

Al47Gd48Ni4Co1 deformed at strain range=2.53%, specimen failed at 234 cycles

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