ISSN: 2692-5397
DOI: 10.33552/MCMS.2022.05.000602
Modern Concepts in Material Science
Iris Publishers

Mini Review

Applications of Amorphous Metallic Fibers as Reinforcement Materials

Xin Su[1]*, Guangtao Ren[1] and Shuang Su[2]*

[1]School of Materials Science and Engineering, Shenyang University of Technology, China
[2]School of Materials Science and Engineering, Harbin Institute of Technology, China

***Corresponding author:** Xin Su, School of Materials Science and Engineering, Shenyang University of Technology, Shenyang 110870, China and Shuang Su, School of Materials Science and Engineering, Harbin Institute of Technology, Harbin 150001, China.

Received Date: October 18, 2022
Published Date: November 14, 2022

Abstract

Since the 1980s, the research and application of amorphous metallic fibers (AMFs) have been set off in the world. AMFs have many good properties such as high strength, high hardness, high toughness, excellent electromagnetism and wear resistance, etc. AMFs have a proper place in materials because of their unique advantages, such as electromagnetic properties, wear resistance and strength. Some AMFs can be used as concrete reinforcing materials to be added to other materials since they are of large elastic limits, improved plasticity and strong corrosion resistance. In addition, the mechanical properties of AMFs used as additional materials after heat treatment need to be further studied.

Keywords: Amorphous metallic fibers; Mechanical properties; Reinforcing materials; Heat treatment

Mini Review

Nowadays, extensive study of micro-scale metallic fibers of various kinds of materials has revealed that they would improve performance and extend functionality of bulk materials [1,2]. At the same time, Amorphous metallic fibers (AMFs) have generated a lot of interest and found applications as reinforcement added to other materials due to intriguing fundamental effects they exhibit, including higher tensile strength and higher number of fibers per unit volume in comparison to ordinary steel fibers [3,4]. The tensile strength of some AMFs almost exceeds that of glass fiber, carbon fiber and piano wire, such as $Fe_{75}Si_{10}B_{15}$ AMFs, which can reach 3570 MPa [5]. As a representative of high strength materials, AMFs were first developed over 60 years ago and have been widely studied all over the world, since the amorphous alloys are of chemical homogeneity and absence of crystalline defects such as grain boundaries, segregation, dislocation, and precipitates [6-10]. As a concrete reinforcing material, AMFs enhance the resistance to compression and cracking, as well as the flexural strengths and the long-term durability. In previous studies, it was also found that, owing to their unique functional properties, AMFs offer important opportunities in technological applications that include biodegradable implants, electrocatalysts and microelectromechanical systems. Such studies would be of great fundamental interest and vital importance for advanced applications. Lee et al. [11] prepared Ni-Nb-Ta amorphous metallic strip-Al matrix composites with micron thickness by infil-

tration casting process. The strip-Al alloy composites obtained by this process have good interfacial bonding and excellent mechanical properties. However, the mechanical properties of AMFs often change with the environment when they are used as additional materials in practical applications, especially in high-temperature environment. Therefore, it is necessary to study the mechanical properties of AMFs after heat treatment. As well known, heat treatment will change amorphous structure to crystal structure, and thus mechanical properties of AMFs changes [11]. Wang et al. [12] studied the effect of annealing on the mechanical properties of AMFs. They found the fracture strength decreased and no obvious plastic deformation occurred. However, up to date, there is a limited understanding of how heat treatments influence the microstructure and mechanical properties of AMFs, making it challenging to control and tailor the final properties of composite materials. Moreover, the effects of annealing conditions on AMFs with different compositions remain underexploited at the atomic scale.

Rationally utilizing the excellent performance of AMFs will be of great fundamental and vital significance for advanced applications. Further study of the effect of heat treatment on the performance of AMFs is challenging but needs to be further explored.

Acknowledgement

None.

Conflict of Interest

The authors declare no conflict of interest.

References

1. Begich Y, Klyuev S, Jos V, Cherkashin A (2020) Fine-grained concrete with various types of fibers. Magazine of Civil Engineering 97(5).
2. Gong P, Deng L, Jin J, Wang S, Wang X, et al. (2016) Review on the research and development of Ti-based bulk metallic glasses. Metals 6(11): 264.
3. Kruzic JJ (2016) Bulk metallic glasses as structural materials: a review. Advanced Engineering Materials 18(8): 1308-1331.
4. Kim H, Kim G, Lee S, Choe G, Noguchi T, et al. (2019) Direct tensile behavior of amorphous metallic fiber-reinforced cementitious composites: Effect of fiber length, fiber volume fraction, and strain rate. Composites Part B: Engineering 177: 107430.
5. Inoue A, Amiya K, Katsuya A, Masumoto T (1995) Mechanical properties and thermal stability of Ti-and Al-based amorphous wires prepared by a melt extraction method. Materials Transactions JIM 36(7): 858-865.
6. Wang WH, Dong C, Shek C (2004) Bulk metallic glasses. Materials Science and Engineering: R: Reports 44(2-3): 45-89.
7. Cui J, Luo Q, Di S, Zhang Z, Shen B (2022) Rejuvenation-to-Relaxation Transition Induced by Elastostatic Compression and Its Effect on Deformation Behavior in a Zr-Based Bulk Metallic Glass. Metals 12: 282.
8. Rösner H, Kübel C, Ostendorp S, Wilde G (2022) In Situ Generated Shear Bands in Metallic Glass Investigated by Atomic Force and Analytical Transmission Electron Microscopy. Metals 12(1): 111.
9. Zhou S, Zhang T, Li L, Yang J, Zhang M, et al. (2021) Fatigue Behavior of $Zr_{58}Cu_{15.46}Ni_{12.74}Al_{10.34}Nb_{2.76}Y_{0.5}$ Bulk Metallic Glass Fabricated by Industrial-Grade Zirconium Raw Material. Metals 11(2): 187.
10. Kim WC, Lim KR, Kim WT, Park ES, Kim DH (2022) Recent advances in multicomponent NiTi-based shape memory alloy using metallic glass as a precursor. Progress in Materials Science 123: 100855.
11. Lee M, Kim JH, Park J, Kim J, Kim W, et al. (2004) Fabrication of Ni–Nb–Ta metallic glass reinforced Al-based alloy matrix composites by infiltration casting process. Scripta materialia 50(11): 1367-1371.
12. Wang CD, Zhang ZH, Xie JX (2010) Influence of annealing on them magnetic and mechanical properties of glass-coated $Fe_{69}Co_{10}Si_8B_{13}$ microwires. Journal of Functional Materials and Devices 16: 22-28.