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Thin Film Metallic Glasses: Unique Properties and Potential Applications

Jinn P. Chu*
Dept. of Materials Science and Engineering, National Taiwan University of Science and Technology, Taipei, Taiwan, Republic of China
***E-mail: jpchu@mail.ntust.edu.tw**

A new group of thin film metallic glasses (TFMGs) have been reported to exhibit properties different from conventional crystalline metal films, though their bulk forms are already well-known for the high strength and toughness, large elastic limits, excellent corrosion and wear resistances because of the amorphous structure. In recent decades, bulk metallic glasses (BMGs) have gained a great deal of interest due to the substantial improvements in specimen sizes. On the other hand, much less attention has been devoted to the TFMGs, despite the fact that they have many properties and characteristics which are not readily achievable with other types of metallic or oxide films. Furthermore, these TFMGs have been progressively used for engineering applications and thus deserve to be recognized in the field of thin film coatings.

In addition, while the BMGs are still difficult to use because of their brittle macroscopic nature and difficulty of processing, TFMGs are a possible solution to make use of their great properties of high strength, large plasticity, and excellent wear resistance. In this presentation, which is based on the review article [1], many advantages and properties of TFMGs are discussed. These are such as mechanical properties, tribological properties, annealing-induced amorphization and resulting smooth surface, some of which lead to useful applications, for example, for substrate fatigue property enhancements [2]. Further, potential applications in optoelectronics and microelectronics are mentioned. For the use in optoelectronics, the TFMG is used to enhance the performance and endurance of carbon nanotube field emission cathode [3]. As a potential barrier with the thickness as thin as 25 nm, TFMG is also shown to effectively block the Cu/Sn interaction and thus mitigate the Sn whisker growth in the microelectronic package application [4]. An amorphous oxide active layer based on TFMG, with a thin thickness of ~15nm, is reported to exhibit desirable resistive switching property with high resistance ratio, long retention time, good endurance, low voltage (<1.7V) consumption and no needs for thermal or electrical-forming [5].

Ironically, there have been enormous research efforts dedicated to developing metallic glasses with large critical sizes only to reveal that the best use for these materials may, in fact, be in thin film applications. It is thus hoped that this talk serves the purpose of calling attention to the importance of TFMGs such that many more studies and applications may be explored.

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