日本材料学会 金属ガラス部門委員会
協賛:特別講演会のご案内

平成 24 年 7月27日

金属ガラス部門委員会
委員　各位

金属ガラス部門委員会
委員長　早乙女 康典

平素より、日本材料学会・金属ガラス部門委員会の活動では、お世話になっております。金属ガラス部門委員会の協賛事業として，下記のように特別講演会を開催いたしますので、万障お繰り合わせの上ご出席下さいますようご案内申し上げます。

記

日本材料学会　金属ガラス部門委員会　特別講演会　開催要領

〇日　時：平成 24 年８月３日（金）　15:00-17:00
〇会　場：兵庫県立大学姫路書写キャンパス 5 号館 5204 教室
〇主催：兵庫県立大学大学院附属　ナノ・マイクロ構造科学研究センター
　協賛：日本材料学会　金属ガラス部門委員会
〇アクセス　http://www.eng.u-hyogo.ac.jp/info/guide/fs_access.html
〇テーマ　「最近の金属ガラスの研究開発」
〇プログラム

1) 15:00～15:40
"Fatigue Behavior of Bulk-Metallic Glasses"
Professor Dr. Peter K. Liaw
Dept. of Materials Science and Engineering, Univ. of Tennessee, Knoxville, U. S. A.

2) 15:40～16:20
"Deformation Monitoring of Metallic Glass by Electrical Resistance Change"
Assistant Professor Dr. Eun Soo Park,
Dept. of Materials Science and Engineering, Seoul National Univ., Seoul, Korea

3) 16:20～17:00
"Recent Progress of Zr-based Bulk Amorphous Alloys",
Associate Professor Dr. Yoshihiko Yokoyama,
Institute for Materials Research, Tohoku Univ., Sendai, Japan

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Fatigue Behavior of Bulk-Metallic Glasses

Peter K. Liaw

Dept. of Materials Science and Engineering, Univ. of Tennessee, Knoxville, U. S. A.

Results from our fatigue investigation are reported for the Zr-Cu-Al bulk-metallic glass. Such materials are noted for having no grain boundaries and dislocations. However, their excellent-performance properties for structural applications, such as high yield strength, hardness, and fracture toughness, have promising potentials. Understanding how to predict the fatigue life of such materials is crucially important for their selection as structural materials. These materials reveal a wide range of fatigue life and limit, e.g., 8 - 50 % of the ultimate tensile strength. In our paper, the nature of likely fatigue mechanisms for this type of bulk metallic glasses is revealed. Fatigue cracks, arising from machining/polishing damage, were experimentally observed to initiate from shear bands near defects. At the crack tip, a plastic-zone creation is observed through the formation of many shear bands, and the fatigue crack is found to propagate along these shear bands. The size of the plastic zone correlates with fracture-mechanics quantities, and each fatigue cycle is seen to produce a fine striation instead of a single coarse one. We propose a shear-band mechanism to explain the characteristics of the observed fatigue cracking. Numerical computations, based on linear-elastic-fracture mechanics, yield reasonably good agreement with experiments. The influence of sample chemistry and size on fatigue behavior is discussed. Our findings are significant to understand the fatigue mechanism of bulk-metallic glasses and to predict the fatigue life of bulk-metallic glasses.

Acknowledgements: The projects are supported by the National Science Foundation programs (DMR-0231320, DMR-0909037, CMMI-0900271, and CMMI-1100080) with Drs. C. Huber, D. Finotello, C. V. Cooper, and A Ardell as program directors.

Short Biography: Peter K. Liaw was born in Chiayi, Taiwan. He graduated from the Chiayi High School, obtained his B.S. in Physics from the National Tsing Hua University, Taiwan, and his Ph.D. in Materials Science and Engineering from Northwestern University, USA, in 1980.

After working at the Westinghouse Research and Development (R&D) Center for thirteen years, he joins the faculty and becomes an Endowed Ivan Racheff Chair of Excellence in the Department of Materials Science and Engineering at the University of Tennessee (UT), Knoxville, since March 1993. He has been working in the areas of fatigue, fracture, nondestructive evaluation, and life-prediction methodologies of structural alloys and composites. Since joining UT, his research interests include mechanical behavior, nondestructive evaluation, biomaterials, and processing of high-temperature alloys and ceramic-matrix composites and coatings with the most kind and great help of his colleagues at UT and the near-by Oak Ridge National Laboratory. He has published over five hundred journal papers, edited more than sixteen books, and presented numerous invited talks at various national and international conferences.

He was awarded the Royal E. Cabell Fellowship at Northwestern University. He is a recipient of numerous "Outstanding Performance" awards from the Westinghouse R&D Center. He was the Chairman of the TMS (The Minerals, Metals and Materials Society) "Mechanical Metallurgy" Committee, and the Chairman of the ASM (American Society for Metals) "Flow and Fracture" Committee. He has been the Chairman and Member of the TMS Award Committee on "Application to Practice, Educator, and Leadership Awards." He is a fellow of ASM. He has been given the Outstanding Teacher Award, the Moses E. and Mayme Brooks Distinguished Professor Award, the Engineering Research Fellow Award, the National Alumni Association Distinguished Service Professor Award, the John Fisher Professorship, and L. R. Hesler Award at the University of Tennessee, and the TMS Distinguished Service Award.

He has been the Director of the National Science Foundation (NSF) Integrative Graduate Education and Research Training (IGERT) Program, the Director of the NSF International Materials Institutes (IMI) Program, and the Director of the NSF Major Research Instrumentation (MRI) Program at UT. Several of his graduate students have been given awards for their research and presentations at various professional societies and conferences. Moreover, his students are teaching and doing research at universities, industries, and government laboratories.

Collaborators: G. Wang, X. Jin, Y. Yokoyama, E. W. Huang, F. Jiang, L. M. Keer, A. Chuang, M. Freels, G. Y. Wang, J. Chu, W. Dmowski, R. Li, P. Tong, D. Louca, Y. Shi, T. Yuan, J. C. Huang, J. S. C. Jang, D. Jang, R. Maars, J. R., Greer, T. Egami, T. Zhang, M. Demetriou, A. Wiest, K. A. Dahmen, W. L. Johnson, and A. Inoue

Deformation Monitoring of Metallic Glass by Electrical Resistance Change

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When a material is subjected to stress, its strain response is generally made up of several components, each differing by its dependence on time, the degree to which it is recovered upon removal of the stress, and the linearity of the response. Metallic glass alloy systems have been reported to exhibit at least four strain components: (a) ideal elasticity (recoverable, instantaneous, linear stress-strain relation); (b) anelasticity (recoverable, time-dependent, linear stress-strain relation); (c) viscoelasticity (permanent, time-dependent, linear stress-strain relation); and (d) instantaneous plasticity (permanent, instantaneous, non-linear stress-strain rate relation). These strain components eventually cause different degree of internal structural changes in metallic glasses during deformation. Although several studies of shear band behavior and some theories of shear localization in metallic glasses have been advanced, our understanding of how internal structural changes affect glassy materials' properties as well as how a shear deformed area such as a shear band initiates and propagates during deformation is still limited. In the present study, we try to evaluate the relationship between electrical resistance changes and internal structural changes during deformation. We carefully control the deformation conditions during bending and bending fatigue test of metallic glass ribbons to modulate the amount of deformation of metallic glasses. Especially, using a self-designed experimental setup, we detect variation of electrical resistance in real-time as the bending and bending fatigue progress. As a result, we expect to evaluate a correlation between resistance changes and internal structural changes, such as viscoelastic structural changes as well as shear band density, which might be used as an indicator of the degree of deformation in metallic glasses. These results might be helpful in understanding dynamic behaviors of structural changes during deformation and the role of shear deformed areas in determination of key characteristics of metallic glasses.

Recent Progress of Zr-based Bulk Amorphous Alloys

Yoshihiko Yokoyama

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An amorphous alloy is characterized by its own unique loosely packed random structure and some properties of amorphous alloy originate to the unique random structure; i.e. thermoplastic deformation due to glass transition phenomena and inhomogeneous deformation due to no operable dislocation. In order to achieve the potential for industrialization of cast bulk amorphous alloys, following problems should be solved; 1) structural relaxation embrittlement, 2) low fatigue endurance limit, 3) no tensile plasticity, 4) insufficient reproducibility, and so on. I have been tried to solve above problems, some of recent topics will be presented in the presentation.

1.Structural relaxation embrittlement

Amorphous alloys have an intrinsic phenomenological structural degradation under heating called structural relaxation, and it is sometimes accompanied by embrittlement. For the avoidance of fatal embrittlement, I examined the compositional and annealing effect on mechanical properties of Zr-TM-Al (TM: Cu, Ni, Co) bulk amorphous alloys. I found that hypoeutectic Zr-Cu-Al bulk glassy alloys exhibit intrinsic softening and almost no degradation of mechanical properties due to structural relaxation.

2. Plasticity enhancement of monolithic amorphous alloy

Furthermore, in the quaternary Zr-Ni-Cu-Al alloys, the hypoeutectic $Zr_{70}Ni_{16}Cu_6Al_8$ bulk glassy alloy with extremely low Young's modulus (70 GPa) and high Poisson's ratio (0.39) enables to show apparent tensile plastic elongation at room temperature. We also examined tensile plasticity of the hypoeutectic BMG at low temperature with various strain rates.

3. Mass production process of Zr-based amorphous alloys

High reproducibility, that is required for the standardization and industrialization of metallic glasses, will achieve by the development of key technical issues for automatic mass production process. The developed mass production process is mainly composed of three components; weighing, alloying and casting, respectively. Making full use of the mass production system, meaningful progress might be expected on the quality control of metallic glass because of the avoidance of human error and dependence on human skill.