Structural modeling and mechanical behavior of particle reinforced metal matrix composites

Yishi Su, Zhiqiang Li, Qiang Guo, Dingbang Xiong, Genlian Fan, Di Zhang
State Key Laboratory of Metal Matrix Composites, Shanghai JiaoTong University, China

Particle reinforced metal matrix composites (MMCs) have the very large potential to provide ultrahigh mechanical properties, for example specific stiffness and specific strength, in the civil and defense applications as well as the automotive and aerospace industries [1]. Considering the materials characteristics and producing processes, composite structures of particle reinforced MMCs largely depend on their reinforced particles [2], such as: the sizes, the shapes, the positions and the contents in the MMCs. Meanwhile, the particle-matrix interfaces are also largely retained and they further affect the mechanical behaviors of particle reinforced MMCs [3]. However, it is very difficult to completely use experimental analysis to find the key parameters in the composite structures, which should be improved to optimize the overall tensile behavior of particle reinforced MMCs [4]. Along with structural modeling of particle reinforced MMCs, the cohesive interfacial model was introduced to carry out the mechanical deformation of particle reinforced MMCs [5]. These structural models of particle reinforced MMCs are based upon experimental observations that can provide useful guidelines to a certain extent for optimum composite structures design. Therefore, a long way still exists to go before the potential of particle reinforced MMCs can be wholly achieved to develop new strong and lightweight materials in both material design and industrial applications.

The present work aims to investigate the intrinsic relation between the mechanical behavior and composite structure coupling with particle-matrix interfacial behavior within the particles (e.g. SiC and CNT) reinforced aluminum matrix composites [6, 7]. Based on the statistical geometrical information of numerous reinforced particles, a developed three-dimensional (3D) structural modeling program can not only establish structural models close to reality of reinforced particles, but also reproduce composite structures similar to those of actual particle reinforced MMCs. In these created structural models, the random dispersions of the sizes, the shapes, the positions and the contents of reinforced particles can be realized according to the structural characteristics of composites. To perform the mechanical behaviors of particle reinforced MMCs, elastoplastic mechanical properties with particle-matrix interfacial behaviors are applied, and reasonable loads and boundaries are conducted. The results indicate that the particle content, matrix strengthening and interfacial behavior play the significant role in the enhancing effect, in order to understand the mechanical deformation in the particle reinforced MMCs.

References

D. Zhang, G.D. Zhang, Z.Q. Li, Mater. China 29 (2010) 1-7.

J. Llorca, C. Gonzalez, J. Mech. Phys. Solids 46 (1998) 1–28.

N. Chawla, Y.L. Shen, Adv. Eng. Mater. 3 (2001) 357-370.

I.A. Ibrahim, F.A. Mohamed, E.J. Lavernia, J. Mater. Sci. 26 (1991) 1137-1156.

N. Chandra, H. Li, C. Shet, H. Ghonem, Int. J. Solids Struct. 39 (2002) 2827–2855.

Y.S. Su, Q.B. Ouyang, W.L. Zhang, *et al.*, Mater. Sci. Eng. A 597 (2014) 359-369

Y.S. Su, Z.Q. Li, L. Jiang, *et al.*, Mater. Sci. Eng. A 614 (2014) 273-283

Biography:

Dr. Su Yishi completed his PhD from the University of Technology of Troyes, France and postdoctoral research from Shanghai Jiao Tong University. Currently, he is the assistant Professor of Shanghai Jiao Tong University and the member of Japan Institute of Metals. He has chaired and participated the National Natural Science Foundation, the National Basic Research Program and Shanghai Materials Genome Program of China. He has published more than 10 peer-reviewed papers in *Materials Science and Engineering A*, *Journal of Composite Materials* and other journals. His current research interests are focused in the Metal Matrix Composites and Materials Genome Computation.