Foreword

This thesis consists of an in-depth study of investigating microstructure–property relationships in bulk metallic glasses using a novel quantitative approach by which influence of the second phase features on mechanical properties can be independently and systematically analyzed. We adopted this strategy to evaluate and optimize the elastic and plastic deformation, as well as the overall toughness of cellular honeycombs under in-plane compression and porous heterostructures under uniaxial tension. The first study revealed three major deformation zones in cellular metallic glass structures, where deformation changes from collective buckling showing nonlinear elasticity to localized failure exhibiting a brittle-like deformation, and finally to global sudden failure with negligible plasticity as the length to thickness ratio of the ligaments increases. For the second case, it has been found that spacing and size of the pores, the pore configuration within the matrix, and the overall width of the sample determines the extent of deformation, where the optimized values are attained for pore diameter to spacing ratio of one with AB-type pore stacking.

In general, this versatile concept can also provide an insight to a wide range of problems including very complicated microstructural architectures, stochastic foam designs found in nature, as well as flaw tolerance and sensitivity studies of different classes of materials.

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