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The fracture of bulk metallic glasses

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ABSTRACT

The fracture of metallic glasses has received relatively little attention until recently. The development of bulk metallic glasses (BMGs) with more compositions, large sample sizes and diverse fracture behaviors provides a series of ideal model systems for the study of fracture in glassy materials. The fracture toughness of different BMGs varies significantly from approaching ideally brittle to the highest known damage tolerance. Diverse fracture patterns on the fracture surface, fracture modes and dynamic propagation of cracks have been observed in different BMGs. In this review paper, we present a comprehensive view of the state-of-the-art research on various aspects of the fracture of BMGs, including fracture behavior and characteristics, fracture mode, fracture criterion, fracture toughness, and fracture morphology. Accumulated experimental data on BMG fracture are presented and their possible theoretical connections with continuum fracture mechanics and the atomic-scale process are introduced and discussed. Modeling studies of the fracture of BMGs by various computational methods are also reviewed. The review also presents a number of perspectives, including the relation of BMG fracture study to other topics, and unsolved issues for future investigation.

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1. Introduction

Metals and alloys, which have been the most important material class used by human beings for thousands of years, are crystals. This is mainly due to the non-directional nature of metallic bonding, which allows metallic liquid to crystallize much more easily than the melts of covalent bonding matters including organics and polymers. Amorphous alloys, also known as metallic glasses, with the