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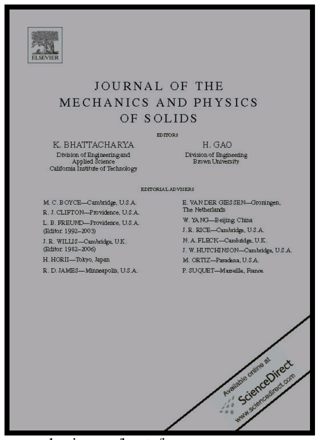

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On the fracture of high temperature alloys by creep cavitation under uniaxial or biaxial stress states

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Abstract

It is well known that creep rupture in high temperature alloys is caused by grain boundary cavitation: the nucleation, growth, and coalescence of voids along grain boundaries. However, it has been observed recently that the multiaxial rupture behavior of a promising class of high temperature alloys (Tung et al., 2014) cannot be captured by a well-known empirical creep rupture model due to Hayhurst. In an effort to gain a better understanding of rupture in these materials, we depart from empirical models and simulate the underlying rupture mechanisms directly, employing two related models of void growth from the literature: one due to Sham and Needleman (1983), and an extension of Sham and Needleman's model due to Van der Giessen et al. (1995). Our results suggest that the experimental observations might be explained in terms of the interplay between bulk creep and gain boundary diffusion processes. Furthermore, we find that Sham and Needleman's original void growth model, combined with our rupture model, is well suited to capture the experimental data considered here. Such a mechanism-based understanding of the influence of multiaxial stress states on the creep rupture behavior of high temperature alloys promises to be of value and to provide a basis for the qualification of these alloys for extended service in a variety of elevated temperature applications.

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