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The Dynamic Failure Behavior of Tungsten Heavy Alloys Subjected to Transverse Loads

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Tungsten heavy alloys (WHA), a category of particulate composites used in defence applications as kinetic energy penetrators, have been studied for many years. Even so, their dynamic failure behaviour is not fully understood and cannot be predicted by numerical models presently in use.

In this experimental investigation, a comprehensive understanding of the high-rate transverse-loading fracture behavior of WHA has been developed.

Dynamic fracture events spanning a range of strain rates and loading conditions were created via mechanical testing and used to determine the influence of surface condition and microstructure on damage initiation, accumulation, and sample failure under different loading conditions.

Using standard scanning electron microscopy metallographic and fractographic techniques, sample surface condition is shown to be extremely influential to the manner in which WHA fails, causing a fundamental change from externally to internally nucleated failures as surface condition is improved. Surface condition is characterized using electron microscopy and surface profilometry.

Fracture surface analysis is conducted using electron microscopy, and linear elastic fracture mechanics is used to understand the influence of surface condition, specifically initial flaw size, on sample failure behaviour. Loading conditions leading to failure are deduced from numerical modelling and experimental observation. The results highlight parameters and considerations critical to the understanding of dynamic WHA fracture and the development of dynamic WHA failure models.