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Edge Toughness of Tungsten Carbide Based Hardmetals

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Keywords

Hardmetal, toughness, test method

Abstract

Edge flaking of WC-based hardmetals has been examined in detail. So-called "edge toughness"; the load at which a flake will form under load *vs*. displacement from the specimen edge has been correlated with more commonly used toughness parameters; Palmqvist toughness, plane strain fracture toughness (K_{IC}) and critical strain energy release rate (G_{IC}). K_{IC} and G_{IC} showed better correlations than Palmqvist, though coarser grained hardmetals, exhibiting rising R-curves, were consistently found to be outliers. It is thought that this behaviour is consistent with far more pronounced crack bridging in these materials in the edge fracture mode. Mechanical property data were complimented by SEM microscopy to examine fracture behaviour in more detail.

Introduction

The work reported herein has been conducted for two principal reasons. Firstly, to further the understanding of an alternative toughness parameter which can be applied to brittle materials which has the potential to be easy to measure and does not require the complex geometries and technical difficulties associated with more traditional notched beam samples. Palmqvist toughness is commonly used measure of resistance to crack propagation in brittle materials such as technical ceramics, cermets and hardmetals. However, Palmqvist toughness is not universally applicable to tungsten carbide hardmetals; in some materials discrete measurable cracks are not produced from the corners of Vickers indentations. In some cases it is possible to ameliorate this by increasing the force on the indenter, but at high loads chipping of the indenter can and does occur. Also, due to scaling effects in hardness measurement, increasing loads means the results are not universally applicable. The second driver for exploring edge chipping further is quality assurance in the hardmetal industry. The transverse rupture test (TRS) is well established as a benchmark mechanical property test, but suffers from several drawbacks. Amongst the latter are a lack of discriminability and also the need for large sample batches to be tested to give a set of results that can be regarded as being representative of the whole population. Such large sample batches are expensive to produce and despite such advances as automated bend testing without the need for an operator, the overall cost is high. Edge chipping offers the potential of providing populations of mechanical data which do not require the sample volumes and degree of preparation which TRS entails.