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This Week's Citation Classic

Tattersall H G & Tappin G. The work of fracture and its measurement in metals, ceramics and other materials. J. *Mater. Sci.* **1**:296-301, 1966. [Ceramics Division, Atomic Energy Res. Estab., Harwell, Berks., England]

A method of measuring the work of fracture is described and assessed. Typical values for a number of materials are given and various mechanisms for the energy absorption associated with fracture are considered. [The *SCI*® indicates that this paper has been cited over 120 times since 1966.]

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"Working in the ceramics division, I was concerned with measuring work of fracture for brittle materials, in particular polycrystalline ceramics. At that time, work of fracture in brittle materials was obtained by measuring the force required to start a crack running in a suitably shaped and notched specimen. It was usual for the specimen to break catastrophically.

"The application of existent methods revealed two shortcomings. First, the specimen had to be a shape suitable for mathematical analysis rather than practical convenience. Secondly, one always had to believe in the existence of unseen sharp microcracks at the bottom of rounded notches, in order to have faith that the method was valid. Nevertheless, this was an established technique, and for a year I was preoccupied with adapting it for my purpose. Some effort was spent measuring a generalised compliance of a conveniently shaped specimen as a function of notch size, which would enable elastic energy release rate to be inferred rather than calculated, to eliminate the first shortcoming. Then, a method of introducing a sharp (i.e., genuine) crack into the specimen was sought, to eliminate the second shortcoming. In all this, the papers by J.P. Berry[1,2] were a constant source of inspiration, as they contained the theoretical aspects of what I sought to make a practical reality for brittle materials.

"I have always felt that significant advances in science are more likely to be discoveries than deliberate developments, and my experience with work of fracture seems to confirm this. I was developing a means of introducing a sharp crack into a brittle specimen (without breaking it completely!) when the discovery was made that it was possible to make a direct measurement of the work done in breaking a specimen. I actually had broken my first specimen in a controlled manner, and obtained a force-deflection curve from it (thus measuring the work done), before realising that I had measured work of fracture, and for this reason I call it a discovery. My notebook tells me this occurred on Christmas Eve 1963. It is another property of discoveries that they always occur at the very end of the day/term/year.

"Because the paper described a technique, it was likely that it would be cited often if the technique were valid and found general use. So why is this method so attractive? It is a simple method, which commends itself to the imagination, being a 'direct' measurement of work done. The principle of the technique is easily explained to anyone, at any depth of detail. More importantly, it gives a low value of fracture energy. If one can demonstrate that a specimen can be broken with the expenditure of less energy than another technique would measure, then the lower energy technique must be more nearly correct. The energy to break a specimen is used both in the fracture process and in other mechanisms as well —e.g., plastic flow unconnected with the fracture process. There is thus an implied challenge to break a material using less energy than ever before."

1. **Berry J P.** Some kinetic considerations of the Griffith criterion for fracture—I. Equations of motion at constant force. J. *Mech. Phys. Solids* **8**:194-206, 1960.
2. .... Some kinetic considerations of the Griffith criterion for fracture—II. Equations of motion at constant deformation. *J. Mech. Phys. Solids* **8**:207-16, 1960.