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Temporal and Spatial Studies of Embedded Triboluminescent Crystals

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Triboluminescence (TL) is the phenomenon whereby fracture of a material gives rise to the emission of light. This process has long been known, but currently has no practical applications. It has been suggested that TL materials may be useful as damage sensors in smart materials. The physics of the light emission upon fracture is here investigated, particularly when the TL material is embedded into a matrix, as would be necessary for a functional damage sensor.

The fracture mechanisms of composites containing weak inclusions are investigated. This is combined with research into the mechanism of TL emission and it is shown that these can be inter-related and both affect the intensity of light emission observed at the failure of such composites.

The research presented here provides some new insights into the, still relatively poorly understood, mechanisms by which TL occurs. The mechanism of the TL of piezoelectric crystals is adapted to take into account the release of strain (and piezo-electric polarisation) in the specimen following fracture. The effect of ambient conditions on TL is further investigated. A simpler method for measuring the absolute intensity of TL is presented.

For the first time for small (<500 µm diameter) particles the effects of particle size on TL of crystals has been investigated. It has been shown that, by embedding the particles in a matrix TL is still possible below the size where single crystals are otherwise impossible to fracture in a brittle fashion. The intensity of the luminescence from fracturing small particles is shown to vary with the size of the particles with varying effect depending on the mechanism of the TL. It is shown that the reduction of particle size can increase, reduce or have no effect on the TL efficiency. This provides a new and innovative technique for studying the mechanism of TL.

To be functional as a damage sensor the embedded TL particles must fracture if, and only if, the surrounding matrix does, but must not weaken the component. The fracture behaviour of composites containing TL particles are studied under quasi-static and impact loading conditions with the light emission marking the failure of the inclusions.