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The high strain rate response of Ultra High Molecular-weight Polyethylene: from fibre to laminate

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Abstract

The effect of strain rate upon the uniaxial response of Ultra High Molecular-weight Polyethylene (UHMWPE) fibres, yarns and laminates of lay-up $[0/90]_{48}$ has been measured in both the 0/90° and ±45° configurations. The tensile strength of the matrix-dominated ±45° laminate is two orders of magnitude less than that of the fibre-dominated 0/90° laminate, and is more sensitive to strain rate. A piezoelectric force sensor device was developed to obtain the high strain rate data, and this achieved a rise time of less than 1 μs. It is found that the failure strength (and failure strain) of the yarn is almost insensitive to strain rate within the range (10^{-1} - 10^{3} s^{-1}). At low strain rates (below 10^{-1} s^{-1}), creep of the yarn dominates and the failure strain increases with diminishing strain rate. The tensile strength of the dry yarn exceeds that of the laminate by about 20%. Tests on single fibres exceed the strength of the yarn by 20%.