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B.P. Russell, K. Karthikeyan, V.S. Deshpande, N.A. Fleck



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

B. P. Russell*, K. Karthikeyan, V. S. Deshpande and N. A. Fleck

Department of Engineering, Cambridge University,

Trumpington Street, Cambridge, CB2 1PZ, UK

**Corresponding Author (bpr23@eng.cam.ac.uk) +441223 748541*

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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 $0/90^\circ$ and $\pm 45^\circ$ configurations. The tensile strength of the matrix-dominated $\pm 45^\circ$ laminate is two orders of magnitude less than that of the fibre-dominated $0/90^\circ$ 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 $1\ \mu\text{s}$. It is found that the failure strength (and failure strain) of the yarn is almost insensitive to strain rate within the range $(10^{-1} - 10^3\ \text{s}^{-1})$. At low strain rates (below $10^{-1}\ \text{s}^{-1}$), 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%.

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