Accepted Manuscript


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PII: S0263-8223(15)00999-X
DOI: http://dx.doi.org/10.1016/j.compstruct.2015.11.009
Reference: COST 6964

To appear in: *Composite Structures*

Received Date: 29 September 2015
Accepted Date: 3 November 2015

Please cite this article as: Ćwik, T.K., Iannucci, L., Curtis, P., Pope, D., Investigation of the ballistic performance of Ultra High Molecular Weight Polyethylene composite panels, *Composite Structures* (2016), doi: http://dx.doi.org/10.1016/j.compstruct.2015.11.009

# Investigation of the ballistic performance of Ultra High Molecular Weight Polyethylene composite panels

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**Abstract**

The ballistic performance of Dyneema® HB26 and Spectra® 3124 subjected to high velocity impact of steel and copper Fragment Simulating Projectiles was evaluated. A 3D High Speed Digital Image Correlation was used for measurement of the panels front face deformation and the back face deformation. The information obtained from the measurements, along with the post-mortem observation of the panels, allowed to draw conclusions with respect to the importance of various energy dissipation mechanisms that occurred in the tested materials. It was observed that, although Dyneema® HB26 and Spectra® 3124 deform very differently during the impact event, they had a similar ballistic performance.

*Keywords:* Dyneema, Spectra, UHMWPE, ballistics, impact

## 1. Introduction

High performance composite materials are currently extensively used in various defence applications requiring high protection levels and low weight at the same time. Typically, unidirectional (UD) cross ply (X-ply) laminates provide better protection against ballistic threats than composites reinforced with woven fabrics, whereas the latter tend to provide better protection than the UD X-ply laminates when exposed to blast threats. An extensive overview of ballistic studies on fabrics and compliant composite laminates was provided by Cheeseman & Bogetti [1]. The authors noted the importance of material properties and the fabric structure when designing against impact. The influence of the projectile geometry and the striking velocity, as well as many other factors, on the ballistic response of various materials were also discussed. Although a number of publications contributed to increasing the understanding of dynamic behaviour of compliant laminates, the processes occurring in these composites during impacts are still not fully understood. Iremonger & Went [2] conducted ballistic trials on Nylon 6.6/EVA laminates subjected to impact from a 1.1 gram Fragment Simulating Projectile (FSP). The authors noted that the fibres located in front face of the panel experienced one of the two different failure modes (transverse shear of fibres or stretch and tensile failure of fibres) depending on which edge of the projectile they were in contact. Prosser [3] investigated ballistic performance of a multilayer Nylon 6,6 fabric impacted with 0.22 FSPs. The author identified that the work of penetration per interior layer was constant. Penetration mechanisms were described in part II of his work [4], which is focused on providing more evidence that the major mode of failure of the Nylon panels impacted by the FSP were cutting and shearing mechanisms. Ballistic performance of Nylon 6,6 was also compared with the performance of Kevlar 29 in Figucia et al. [5]. The authors observed that tensile yarn straining was the main energy dissipating mechanisms in the tested fabrics, while the strain wave velocity was concluded to be the most influential parameter affecting the ballistic performance of the materials. An investigation of the ballistic performance of composites reinforced with aramid and ultra high molecular weight polyethylene (UHMWPE) fibres was conducted by Scott [6]. The author compared deformation characteristics, caused by the projectile impact, of rigid and compliant laminates. Similarly to

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