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REVIEW

High strength Kevlar fiber reinforced advanced textile composites

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Abstract

A state of art on characterization of Kevlar fibers and Kevlar fiber reinforced polymer (KFRP) composites is presented to enunciate the limits of further researches in regard of its applicability with the optimized design in today's high-tech era. A proper characterization is very important for enhancing material properties in various applications such as defense, industrial, marine and aerospace. In this review work, research works performed on the mechanical impact and deformation behavior of Kevlar fiber and KFRP composites have been focused. Kevlar fibers possess high fracture toughness and high strength to weight ratio, of high-performance reinforcement in polymer textile composites. Researchers using different modeling approaches such as homogeneous isotropic and orthotropic material model along with the effect of different parameters as fabric weaving pattern, matrix material, and composite fabrication techniques, working and loading conditions are discussed in detail. Due to anisotropic nature of Kevlar fibers; KFRP composites have high ratio of longitudinal tensile to compression strength whereas the compression strength is considerably found to increase after fiber surface treatment. The purpose of this study is to provide the reader with an overview of different strategies applied with the experimental and numerical investigations of high strength Kevlar fibers and KFRP composites at micro/meso/macroscale.

Keywords Textile composite · Para-aramid fiber · Weaving patterns · Numerical analysis · Ballistic impact

Abbreviations

k	Thermal conductivity
T	Temperature
$\dot{\varepsilon}$	Strain rate
E	Young's Modulus
σ_{max}	Peak stress
ε_f	Strain-at-peak stress
V	Impact velocity
u_{trans}	Travel speed of Euler transverse wave
ε	Strain by longitudinal deformation wave
U	Platen displacement
F	Transverse compressive load
E_1	Young's modulus in 1–2 plane of transverse isotropy
E_3	Longitudinal Young's modulus in the fiber direction
U_{12}	Poisson's ratio in plane of transverse isotropy
r	Single fiber radius
2b	Fiber contact width
2w	Compressed fiber width

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Introduction

Textile composites which are fabricated by reinforcing the natural or synthetic fibers or their fabrics within the matrices are widely accepted material. Composite materials show superior mechanical, thermal, electrical and ballistic behavior with a much-reduced weight. These properties can be further customized by some surface treatments as per the technical requirements [1, 2]. Synthetic fibers (organic or inorganic) mainly comprise of aramid (ortho/meta/para-aramid), polyethylene, glass, carbon and boron fibers. Aramid fibers having 1,4-para-substituted aromatic rings (provides thermal stability) are para-aramid-Kevlar fibers poly(*p*-phenylene terephthalamide) designated as PPTA is shown in Fig. 1 [3]. PPTA fibers are made from a condensation reaction between *p*-phenylene diamine and terephthaloylchloride [4, 5] in the presence of unidirectional hydrogen/van der Waals bonds [6]. The para structure of these aramid fibers