

Thermal and Mechanical Properties of Different Textile Fabrics



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Abstract

The increase in awareness of the destruction caused by synthetic fibers on the environment has led to the development of eco-friendly fibers. The researchers have shown a lot of interest in developing such fiber composite which can replace the synthetic fibers. As a result, there is an increase in demand for commercial use of the natural fiber-based composites in recent years for various industrial sectors. In this review, the different sources of natural fibers, their properties, modification of natural fibers and the effect of treatments on natural fibers were summarized.

Keywords: Fiber; Physical properties; Thermal properties; Mechanical properties

Introduction & Discussion

Raw material is one of the most important factors affecting the physicochemical properties of textile materials. Thus, fiber type, fiber property, fiber mixing condition and fiber handling are essential to meet the expected features according to the usage area of the clothing. There were just characteristic fiber types, for example, cotton, fleece, silk, hemp, ramie, jute and kenaf that could be utilized as material items in textile industry. Since the creation of rayon strands called artificial silk, the production and use of artificial fibers have quickly developed [1]. Within this time, the fiber assorted variety of the makers has expanded and the chance of utilizing numerous fiber types with various properties has been made. All fibers have various points of interest and weaknesses, and their needs shift as per their use territory and proposed

purposes. To provide better attributes in clothing techniques it is attempted to consolidate the worthwhile properties of the fibers and to forestall disadvantageous sides of the fibers by blending [2]. This is the purpose why some researchers focus on the analyzing the effect of the fibers and their blends on physicochemical properties of the fabrics and textile. In the case of kenaf fiber, loss of viscosity has been found to be highly sensitive to the conditions under which the textile process occurs [3]. Using a sequence of acidified sodium chlorite, ammonium oxalate and 1% sodium hydroxide treatment generated good quality kenaf fiber [4]. Cotton fabrics coated with chitosan film containing titanium oxide and/or zirconium oxide (composite) showed a positive impact on both the UV-protection and the Gram-positive bacteria (*S. aureus*) and Gram-negative bacteria (*E. coli*) (Figure 1) [5].

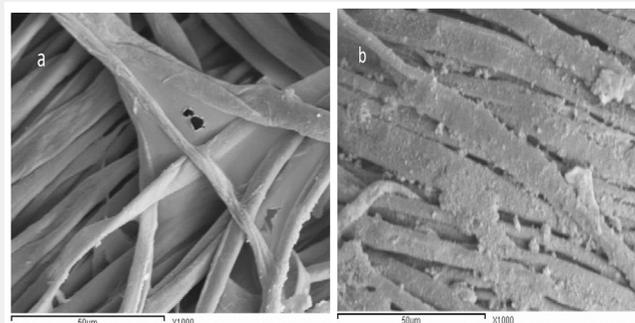


Figure 1: Scanning electron microscope for
a. cotton fabric and
b. cotton blend.

Furthermore, the presence of magnetic nanoparticles (MNPs) in cellulosic fiber showed an expected flame-retardant effect because of a higher char yield observed of the blend (Figure 2) [6,7]. The presence of natural hydroxy appetite (HAp) in cellulosic fibers showed a good porous structure and a high compressive strength (Table 1). Furthermore, the blend shows mass losses at higher temperatures, confirming higher thermal stability as compared to cellulosic fiber, conforming with the obtained

thermodynamic results [8]. On the other hand, heat flow through the textile assembly mostly depends on the thermal conductivity of the fibrous material, fiber volume, construction of the fabric, and orientation of fiber with respect to the heat flow direction [9,10]. Significant research works determine the effective thermal conductivity (Km) and thermal resistance of fabric using mathematical modelling and numerical analysis [11].

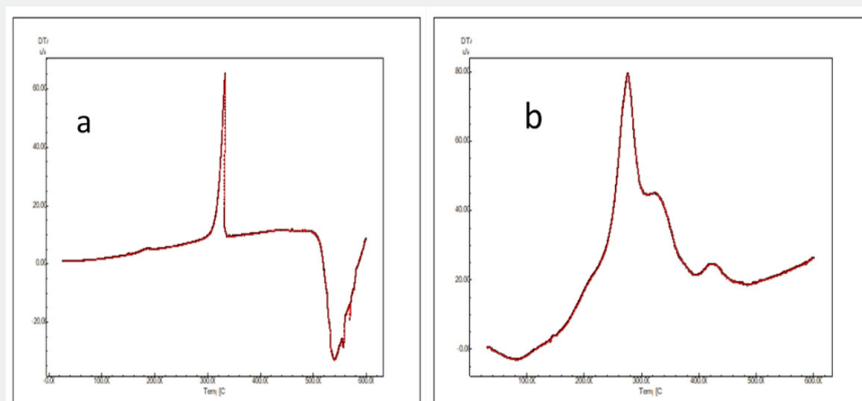


Figure 2: DTA for
 a. cotton fabric and
 b. cotton/MNPs blend.

Table 1: Thermodynamics Activation Parameters for Cellulose and HAp/Cellulose Blend using Coats-Redfern (CR) and Horowitz-Metzger (HM) Methods.

	E, kJ mol ⁻¹		A, s ⁻¹		ΔS*, J mol ⁻¹ K ⁻¹		ΔH*, kJ mol ⁻¹		ΔG*, kJ mol ⁻¹		DTG _{max} °C	Step
	CR	HM	CR	HM	CR	HM	CR	HM	CR	HM		
Cellulose	295(r=0.99993)	284(r=0.99991)	1.50E+18	9.86E+20	96.5	150	254	278	191	180	320	2 nd
HAp_a/cellulose	103 (r=0.99993)	120 (r=0.99991)	3.26E+05	1.66E+07	146	113	97.2	114	196	191	401	2 nd

The mechanical properties of natural or composite fibers such as fiber strength, elongation, elasticity, and modulus of elasticity are very important in textile fabrics. Mechanicals properties are dependent to several parameters, such as, Fiber type and morphology, filler, fabric structure, methodology and machine conditions. Many diverse mechanical stresses applied to cotton fibers in all the process level [12,13]. Fibers with superior tensile properties are sought because these can:

- Resist failure and quality degradation during the processing and
- Higher quality of yarn and final product are reached.

Many factors such as genetics, environmental conditions, and agronomic practices may contribute to within-plant variability in fiber length [14,15]. The quality of the Natural fiber also affect

mechanical properties, Cotton and lint with excessive trash may excessively cleaning sequences at the gin [16]. The cleaning process (at the gin) is aggressive and tends to decrease mechanical properties of the fibers [17]. Trash and contaminant removal at the gin optimized to preserve fiber quality and so the final textile product [17]. The stress-strain curve behavior of a textile fiber also depends on some other factors. One of the important factors is the earlier mechanical history of the fiber. Another important factor is temperature. In addition, the mechanical characteristics of the fiber depend on the aging time with temperature. The mechanical history along with aging time and temperature affects this viscoelastic behavior [18]. Also, Exceeding the temperature and pressure of hot compaction (over certain values), the mechanical properties of ramie fiber-based composite were found to be deteriorated [19]. The fiber processing in itself, can cause critical change in mechanical behavior of the fiber, For

Natural fiber, As shown by Neagu (2006) [20], fiber wall material is damaged, and walls have collapsed resulting in fibers with lower stiffness and strength. However, fillers addition can affect the energy absorption of the fibers via changing the length and thickness of the composite tubes on the absorbed energy of natural silk/epoxy composite [21]. Whereas mechanical and fracture properties of cellulose-fiber-reinforce epoxy laminates determined the influence of the fiber loading on the mechanical behavior of the cellulose fiber/epoxy composites. They observed that raising the content of cellulose fiber in the polymer matrix enhances mechanical properties [22].

Benjamin et al. [23] examined the influence of lignin on the mechanical properties of the hemp/epoxy composites. They observed that composite showed 145% improvement in impact strength on the addition of 5% w/w lignin. Thermal properties are mostly affected by porosity, moisture regain and density. Fabric weight, thickness, air permeability and density influence hydric properties of textile. Besides, the water vapor permeability index depends on fabric weight, porosity, moisture regain, air permeability and density.

Conclusion

Increased environmental consciousness has resulted in the consumption of natural fiber as an effective reinforcement fiber in polymer matrix composites. The fibers are usually extracted from plants and animals often offer poor resistance to moisture and incompatible nature of fibers become the main disadvantage. Therefore, modification of fibers properties has done through chemical treatments of fibers that improve the adhesion between the fibers and matrix and enhance the physicochemical and mechanical properties of the composites.

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