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Review Article

Surface Modification of Fibre an Aspect of Comfort Properties of Fabric

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Abstract

The most important property of all apparels is comfort. It is a qualitative term and it is one of the most important aspects of clothing. The clothing comfort can be divided into three categories, i.e. physiological, tactile and thermal comfort. Physiological comfort bears little relation to the properties of the fabrics and is mainly related to the latest fashion trend and the acceptability in society. The tactile comfort has relationship with fabric surface and mechanical properties. The thermal comfort is related to the ability of a fabric to maintain the temperature of the skin through transfer of heat and perspiration generated within human body and is determined by movement of heat, moisture and air. Comfort characteristics are related to surface smoothness, air permeability, heat transmittance, and hydrophilicity of fabric. These properties can be attained by fibre surface modification. The surface modification of natural and synthetic fibers through various techniques makes them advantageous by overcoming their inherent drawbacks and successfully utilizing these materials in various applications [1]. This review talks about various fibre surface modification techniques including physical and chemical method and their effect on fabric comfort properties.

Keywords: Comfort; Surface Modification; Heat Transmittance; Hydrophobicity

Introduction

The most important property of all apparels is comfort. It is a qualitative term and it is one of the most important aspects of clothing. The clothing comfort can be divided into three categories, i.e. physiological, tactile and thermal comfort. Physiological comfort bears little relation to the properties of the fabrics and is mainly related to the latest fashion trend and the acceptability in society. The tactile comfort has relationship with fabric surface and mechanical properties. The thermal comfort is related to the ability of a fabric to maintain the temperature of the skin through transfer of heat and perspiration generated within human body and is determined by movement of heat, moisture and air [2]. Distinguished aspect of wear comfort of clothing is "Thermo physiological wear comfort" which concerns with the regulation of heat and moisture transport properties of clothing in order to maintain the heat balance of the body during various levels of activity [3]. Thermal and moisture behavior of clothing can be accessed through different parameters such as thermal conductivity, thermal resistivity, thermal absorptivity, diffusion, sorption, evaporation, wicking, and air and water permeability. Fictionalization of fabrics has been studied by many researchers in order to access the comfortable clothing life. Many researchers have been carried out by modifying structure and using different types of fibre and yarn [4,5]. Development of surface modification process with introduction of some functional groups without deteriorating its instinct property of fiber is the need of the hour [6]. Surface modification is effective for improvement in functionality without changing the bulk characteristics of fibres [7]. The modification of the surface energy of textile fibers is pursued with the aim of improving their own hydrophilicity, wettability, and dyeability or of conferring functional properties such as hydro and oil repellency, soil release, adhesion improvement, and antistatic performances [8]. Modification changes the composition or structure of fibre resulting in improvement of different fiber properties. Modification methods are divided into two groups i.e. chemical modification which involves change in fibre composition and physical modification which includes change in fibre structure [9]. Chemical method includes (ozone-gas treatment, surface

grafting, enzymatic modification, sol-gel technique, micro-encapsulation method and treatment with different reagents) and physical method includes (corona discharge, laser, electron beam and neutron irradiations and Ion beam). This paper deals with detailed study about the different modification techniques and their critical analysis.

Chemical Methods

Chemical modification utilizes the chemical agents to modify the fibre surface. This treatment aims at increasing fibre strength and adhesion between fibre surface and polymer matrix.

Ozone gas treatment

Ozone is excellent oxidizing agent and is used for fibre modification. In this treatment hydrophilic groups are incorporated on fibre surface which results in change in fibre surface chemistry. Oxidation of Wool fibre by ozone gas leads to increase in polymer adsorption by increasing the polarity [10]. Whereas fabric made from Nylon 6 and polyester fibre showed improvement in surface tension of fibres which further increased its moisture regain, water absorption, and dyeing properties in spite of an increase in the crystallinity [11]. Studies showed that increase in moisture absorption will make the fabric comfortable to wear.

Surface Grafting

Chemical modification by Graft copolymerization is an important method to enhance fabric comfort properties such as water absorption, moisture regain and thermal properties [12, 13]. Surface grafting can be performed by different methods such as by chemicals, radiation etc and different procedures. It was observed that Poly (ethylene terephthalate) after grafting with acrylic acid using benzoyl peroxide showed better dyeing behavior and good antibacterial properties [12]. Rayon fiber after grafting of with acrylonitrile (AN) showed improved swelling, dye uptake and thermal properties [13]. The use of polysaccharide Chitosan is highly recommended to minimize the undesirable activities of the antimicrobial products [14].

Enzymatic modification

The use of enzyme in the field of textile and natural fibre modification is rapidly increasing. Enzymatic treatment is eco friendly method of fibre surface modification as it do not discharge harsh effluents to the environment and use milder conditions [15]. Other benefits of this treatment are cost reduction, energy and water saving, improved product quality and potential process integration [16]. This treatment was done on PA 6,6 fabrics by treating with subtilisin enzyme. The results showed significant improvement in hydrophilicity of treated fabric. Hydrophilicity of PET fabric was also improved by using lipase and cutinase enzyme [17]. Improvement in hydrophillicity will make the fabric comfortable to wear.

Sol-Gel Technique

The sol-gel technique is of particular importance for textile materials. The principles of the sol-gel process include hydrolyzation, application and curing [18]. The Deposition of coating on fibre surface in the form of sol gel is applied to improve some fibre properties such as abrasion resistance, UV protection and attains water repellency [19]. After modifying pure cotton fire by zinc oxide nanosol prepared by the sol-gel method its ultraviolet protection property improved significantly [20]. It was also observed that hybrid sol–gel silica coating on silk fabric was effective to improve abrasion resistance and stain-repellency [21].

Micro-Encapsulation Method

In Micro encapsulation method small capsules are made by using tiny particles or droplets surrounded by a coating. This method improves various fabric properties such as fire resistance, anti microbial, thermoregulation of clothing, adds fragrance to fabric and improves dyeability of synthetic fibres [22, 23]. Microcapsules can be applied to textiles by padding, coating, spraying or immersion [24]. It was observed that cotton fabric after being coated with PEG-600 microcapsules (produced by an in-situ polymerization technique using urea formaldehyde) showed improved thermal resistance, which makes the fabric suitable for winter clothing [25].

Physical Methods

Chemical methods for modification include the treatment with chemicals that are toxic and sometimes expensive. Whereas physical method includes, irradiation process to modify the fibre structure. Radiation technology involving low energy use, no chemicals, easy handling, and high treatment speed [26].

Corona Discharge

Corona is a luminous discharge from highly electrically charged surface of an object. This plasma, operates at standard atmospheric pressure, and modifies chemical structure. This method improves the adhesion and hydrophilic property by a significant increase in polar components of the surface free energy [27,28]. The main drawback of corona discharge plasma is it lacks uniformity due to their filamentous nature and cause irreversible thermal damage to polymers [29]. PET fabric after getting modified with corona discharge showed increase in the fibre surface energy and its wet ability [30]. It was also observed that the possibility of wool fabric to be worn next to skin increases after Corona discharge treatment due to high absorbency [31]. Research shows that new pores are developed on fibre surface during plasma treatment which allows more air to penetrate, thereby increasing its air permeability. But water vapour permeability decreased in lyocell fabric due to accumulation of more water vapour in pores [32].

Laser treatment

Laser method modifies the polymers surface without any changes in its bulk properties. This method creates morphological changes on the smooth surface of synthetic fibers, that further changes its physical (roughness) and chemical properties (water absorption, dyeing. Advantage of laser treatment is that the small area can be treated and depending on the level of power chosen, chemical and physical changes can occur [12]. Research shows that

Pulsed CO_2 laser improves dye adsorption property of polyamide and polyester fabrics and antibacterial properties of cotton fabric [33].

Electron-beam modification

Electron beam is a way of radiation that can produce polymer's free radicals. These free radicals combine with each other to form cross links resulting in the formation of a three-dimensional network structure. Research shows that anti creep property was improved in ultra-high molecular weight polyethylene fiber, after the introduction of multifunctional monomer into UHMWPE fibers through supercritical CO2 pretreatment followed by electron beam irradiation [34] Polypropylene fabric showed improved wet ability and Dye ability due to formation of (O-H) and (C=O) groups on the surface of samples after electron beam irradiation [35]. Improvement in water uptake was observed for cotton, cotton/polyester blend and nylon 6 fabrics after electron beam irradiation [36]. It was also observed that irradiation causes cellulose depolymerization and reduced crystallinity [37].

Neutron irradiations and Ion beam

Neutron radiation is a kind of ionizing radiation that consists of free neutrons. Displacement of lattice atoms and the generation of helium and hydrogen by nuclear transmutation significantly change the material properties. Increase in % crystallinity was observed in Polyester fibre after irradiation [38]. This increase results from cross linking of sheath with expanded core region. Ion Implantation method modifies the fibre surface properties and increases its hydrophilicity. The effects induced by energetic ions in polymers strongly depend on ion mass. Heavy ions degrade the material, whereas with light ions the degradation is limited [39]. Research showed that to modify fibre physical and chemical structure energetic O+ ions were implanted into polyurethane fibre filament [40]. Due to creation of new functional groups: OH and C=O on the surface of the fabric, improvement in dye-ability of Polypropylene Fabrics was observed after ion implantation treatment [39].

Conclusion

Clothing comfort is not a naturally attained, but rather a result of evaluated combination of the wearer, environment and clothing attributes [41]. Comfort characteristics are related to surface smoothness, air permeability, heat transmittance, and hydrophilicity of fabric. These properties can be attained by fibre surface modification. The surface modification of natural and synthetic fibers through various techniques makes them advantageous by overcoming their inherent drawbacks and successfully utilizing these materials in various applications [42]. This review talks about various fibre surface modification techniques including physical and chemical method and their effect on fabric comfort properties.

References

1. Juliana Cruz, Raul Fangueiro (2016) Surface Modification of Natural Fibers: A Review. International Symposium on Novel Structural Skins: Improving Sustainability and Efficiency through New Structural Textile Materials and Designs 155: 285-288.
2. GK Tyagi, G Krishna, S Bhattacharya, P Kumar (2009) Comfort aspects of finished polyester cotton and polyester-viscose ring and MJS yarn fabrics. Indian Journal of Fibre and Textile Research 34(2): 137-143.
3. BP Saville (1999) Physical testing of Textiles. Woodhead Publishing, Limited.
4. Sawako Shibata, Machiko Murakami, Kyohei Joko (2014) Effects of the modification of fiber surface on the mechanical properties of cotton fabric. International Conference on Kansei Engineering and Emotion Research pp. 1025-1030.
5. A Das, SM Ishtiaque (2004) Comfort characteristics of fabrics containing twist less and hollow fibrous assemblies in weft. Journal of Textile and Apparel, Technology and Management 3(4): 1-7.
6. L Ammayappan (2013) Eco-friendly Surface Modifications of Wool Fiber for its Improved Functionality: An Overview. Asian Journal of Textile 3(1): 15-28.
7. Tomiji Wakida, Tokino Seiji (1996) Surface Modification of fibres and polymeric materials by discharge treatment and its application to textile processing. Indian Journal of fibre and Textile Research 21(1): 69-78.
8. Franco Ferrero, Monica Periolatto (2016) Modification of Surface Energy and Wetting of Textile Fibers. Wetting and Wettability, Intech.
9. Sheila Shahidi, Jakub Wiener, Mahmood Ghoranneviss (2013) Surface Modification Methods for Improving the Dyeability of Textile Fabrics. Eco-Friendly Textile Dyeing and Finishing, InTech.
10. RH Bradley, IL Clackson, DE Sykes (1993) UV ozone modification of wool fibre surfaces. Applied Surface Science 72(2): 143-147.
11. Muncheul Lee, Myung Sun Lee, Tomiji Wakida, Takako Tokuyama, Goichi inoue, etal. (2006) Chemical Modification of Nylon 6 and Polyester Fabrics by Ozone-Gas Treatment. Journal of Applied Polymer Science 100(2): 1344-1348.
12. M Abdolahifard, S Hajir Bahrami, RMA Malek (2011) Surface Modification of PET Fabric by Graft Copolymerization with Acrylic Acid and its Antibacterial Properties. International Scholarly Research Network 2011: p. 8.
13. Indejeet Kaur, Neelam Sharma, Vandana Kumari (2013) Modification of fiber properties through grafting of acrylonitrile to rayon by chemical and radiation methods. Journal of Advanced Research 4(6): 547-557.
14. Daniela Enescu (2008) Use of Chitosan in Surface Modification of Textile Materials. Roumanian Biotechnological Letters 13(6): 4037-4048.
15. Setara Begum, Jindan Wu, Carrington M Takawira, Jiping Wang (2016) Surface Modification of Polyamide 6,6 Fabrics with an Alkaline Protease Subtilisin. Journal of Engineered Fibers and Fabrics 11(1): 64-74.
16. N Merdan, E Sancak, D Kocak, M Yuksek (2012) Effect of Applied Different Surface Modification Processes with Cellulose Enzyme on Properties of Luffa Fibres. Asian Journal of Chemistry 24(3): 975-980.
17. So Hee Lee, Wha Soon Song (2010) Surface Modification of Polyester Fabrics by Enzyme Treatment. Fibers and Polymers 11(1): 54-59.
18. T Textor (2009) Modification of textile surfaces using the sol-gel technique. Surface modification of textiles, Woodhead Publishing Series in Textiles pp. 185-213.
19. Jolon Dyer, Anita Grosvenor (2011) Protein Fibre Surface Modification, Natural Dyes. InTech.
20. S Vihodceva, S Kukle (2013) Improvement of UV Protection Properties of the Textile from Natural Fibres by the Sol-gel Method. IOP Conference Series: Materials Science and Engineering 49(1).

21. Lavinia de Ferri1, Andrea Lorenzi, Elisa Carcano, Lorenza Draghi, (2016) Silk fabrics modification by sol-gel method. Textile Research Journal p. 1-9.

22. Mazeyar Parvinzadeh Gashti, Julie Willougby, Pramod Agrawal (2011) Surface and bulk Modification of Synthetic Textiles to Improve Dyeability. Textile Dyeing, Intech.

23. Khushboo Shrimali, Dr Ela Manoj Dedhia (2015) Microencapsulation for Textile Finishing. IOSR Journal of Polymer and Textile Engineering 2(2): 1-4.

24. B Ocepek, P Forte Tavčer (2008) Microencapsulation in textiles. XVIth International Conference on Bio encapsulation Ireland p. 1-4.

25. Subhas Ghosh, Prasad Bhatkhande (2012) Encapsulation of PCM for Thermo-Regulating Fabric Application. International Journal of Organic Chemistry 2(4): 366-370.

26. Dongliang Dai, Meiwu Shi (2016) Effects of electron beam irradiation on structure and properties of ultra-high molecular weight polyethylene fiber. Journal of Industrial Textiles 0(00) 1-21.

27. Corona Discharge.

28. Mazeyar Parvinzadeh (2012) Surface modification of synthetic fibers to improve performance: recent approaches. Global Journal of Physical Chemistry 3(2).

29. Brzeziński S, Połowiński S, Kowalczyk D, Karbownik I, Malinowska G (2009) Effect of Corona Discharge Treatment of Polyester Fabrics on their Adhesive Properties. Fibres & Textiles in Eastern Europe 17(4): 98-102.

30. Shirin Nourbakhsh, Ali Ashjaran (2012) Laser Treatment of Cotton Fabric for Durable Antibacterial Properties of Silver Nanoparticles. Materials 5(7): 1247-1257.

31. Xin wang, Yuan Zhao, wenbin li, hao wang (2015) Effect of surface modifications on moisture and thermal behavior of wool fabric. Applied Surface Science 342: 101-105.

32. T Ramachandran, L Hari Gopalakrishnan (2015) Effect of Surface Modification on Comfort Properties of Inner Layer Lyocell Fabric in Multilayered Technical Textiles. International Conference on Systems, Science, Control, Communication, Engineering and Technology 1: 13-16.

33. Ute Henniges, Merima Hasani, Antje Potthast, Gunnar Westman, Thomas Rosenau (2013) Electron Beam Irradiation of Cellulosic Materials-Opportunities and Limitations. Materials 6(5): 1584-1598.

34. S Shahidi, J Payamara, J Wiener (2009) A study on polypropylene fabric using ion irradiation. Archives of Applied Science Research 1(1): 57-64.

35. Mervat S Ibrahim, Kariman MEl Salmawi, Sayeda M Ibrahim (2004) Electron Beam Modification of Textile Fabric for Hydrophilic Finishing. Applied Surface Science 241(3-4): 309-320.

36. Sheila Shahidi, Jakub Wiener (2016) Radiation Effects in Materials book edited by Waldemar A Monteiro. Intech.

37. M Ghoranneviss, S Shahidi, B Moazzenchi, A Rashidi, D Dorranian, et al. Electron Beam Modification of Polypropylen Fabrics. Proceedings of the 3rd International Conference on the Frontiers Plasma Physics and Technology p. 1-7.

38. B Mallick, B behera, Tanmaya Badapanda, Simanchal Panigrahi, Biswanath Parija, et al. (2009) Microstructural analysis of neutron-irradiation induced changes in polyester fibre studied using EPMA. Indian Journal of physics 83(4): 525-529.

39. KH Wong, M Zinke-Allmang, WK Wan, JZ. Zhang, P Hu (2006) Low energy oxygen ion beam modification of the surface morphology and chemical structure of polyurethane fibers. Nuclear Instruments and Methods in Physics Research 243(1): 63-74.

40. B Mallick, RC Behera, T Patel (2005) Analysis of microstress in neutron irradiated polyester fibre by X-ray diffraction technique. Bulletin of Materials Science 28(6): 593-598.

41. Edwin Kamalha, Yongchun Zeng, Josphat I Mwasiagi, Salome Kyatuheire (2013) The Comfort Dimension; A Review of Perception in Clothing. Journal of Sensory Studies 28(6): 423-444.

42. Stefan Brzeziński, Stefan Połowiński, Dorota Kowalczyk, Grażyna Malinowska (2009) Effect of Corona Discharge Treatment on the Surface Strength and Performance Properties of Synthetic Fiber Textiles. Fibers & Textiles in Eastern Europe 17(5): 62-68.

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