APPLICATION OF NANOCLAY ON POLYESTER FABRICS AS A BIO-INSPIRED APPROACH TO IMPROVE MOISTURE MANAGEMENT

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Degree of Master of Philosophy

Department of Chemical and Process Engineering

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Declaration of the candidate & supervisors

I declare that this is my own work and this thesis does not incorporate without acknowledgement any material previously submitted for a Degree or Diploma in any other University or institute of higher learning and to the best of my knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgement is made in the text.

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The above candidate has carried out research for the MPhil thesis under our supervision.

Name of the supervisor: Prof. S. Walpalage

Signature of the supervisor: Date:

Name of the supervisor: Dr. (Mrs.) W.P.S.K. Perera

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Name of the supervisor: Dr. (Mrs.) M.C.W. Somaratne

Signature of the supervisor: Date:

Abstract

Application of nanoclay on polyester fabrics as a bio-inspired approach to improve moisture management

Bio-inspired and biomimetic surface modifications are identified as one of the fascinating areas of research. In this study, nature's way of cooling elephants' body temperature using mud bathing was mimicked to create moisture management in polyester fabric. For that, bentonite nanoclay (BNC) was covalently grafted on polyester fabric using (3-aminopropyl) triethoxysilane (APTES) as a coupling agent. The novel modification method was proved qualitatively and quantitatively using characterization techniques such as X-ray photoelectron spectroscopy (XPS), Fourier-transform infrared (FTIR), X-ray diffraction (XRD), Scanning electron microscope (SEM), Transmission electron microscope (TEM), X-ray fluorescence (XRF) and Thermo gravimetric analysis (TGA). Moisture management tests, and physical and mechanical properties of modified polyester fabric were used to analyse the accomplishment of the modification. Hydroxyl groups on edges of BNC played a vital role in grafting with APTES. Primary amine group in APTES reacted with ester groups in polyester fibres, while silanols reacted with BNC. XRD analysis confirmed grafting of APTES on the surface of BNC without intercalation. XPS and FTIR spectroscopies confirmed the new secondary amide bond formation, while surface morphology was observed from SEM images. The significant enhancement in wettability, absorptive capacity, drying rate and wicking length proved moisture management property of polyester fabric. This fabric coating strongly withstood more than 10 cycles of laundry and against 5000 abrasion cycles. Physical and mechanical properties of modified fabrics remained unchanged, while tensile strength and elongation showed a slight improvement due to fibre preserving aminolysis reaction between APTES and ester groups in polyester fabrics. It is expected that this bio-inspired BNC modified polyester fabric may break the barrier of using polyester in various hydrophilic textile applications.

Keywords: Bentonite nanoclay, Covalent modification, Polyester, Biomimetic, Moisture management.

Dedication

To all my professors and doctors for the extensive knowledge you share with students like me. We are forever grateful to you for your unselfish guidance and especially for increasing our fascination for nanotechnology.

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List of abbreviations

Abbreviation	Description
AATCC	American Association of Textile Chemists and Colorists
APTES	(3-aminopropyl) triethoxysilane
ASTM	American Society for Testing and Materials
BNC	Bentonite Nano Clay
DTG	Derivative Thermo Gravimetric
EDX	Energy Dispersive X-ray spectroscopy
FTIR	Fourier-Transform Infrared
ICP-MS	Inductively Coupled Plasma Mass Spectrometry
IR	Infar Red
NRC	National Research Council
SEM	Scanning Electron Microscope
SLINTEC	Sri Lanka Institute of Nanotechnology
TEM	Transmission Electron Microscope
TGA	Thermo Gravimetric Analysis
XPS	X-ray Photoelectron Spectroscopy
XRD	X-Ray Diffraction
XRF	X-Ray Fluorescence

List of appendices