

**DEVELOPMENT OF CONDUCTIVE AND
BIODEGRADABLE NANOFIBROUS YARNS: STUDY
OF ELECTRICAL AND MECHANICAL PROPERTIES**

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Degree of Master of Science

Department of Textile and Clothing Technology

University of Moratuwa

Sri Lanka

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Thesis submitted in partial fulfillment of the requirements for the
degree Master of Science in Textile and Clothing Technology

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Declaration

“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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Abstract

Electrically conductive and biodegradable materials are desired for a vast array of applications in wearable and flexible electronic areas to address the growing ecological problem of e-waste. Herein, we report on the design and fabrication of all-organic, conductive and biodegradable yarn using polyaniline (PANi) and polycaprolactone (PCL). The process of PANi incorporation is achieved in two ways; i) electrospinning a blend of PANi and PCL solution ii) in-situ polymerization of PANi on the nanofibrous surface of PCL electrospun fibers. The electrospun PANi incorporated webs are cut into ribbons and twisted to develop twisted yarns. A customized setup was used to produce continuous electrospun yarns. The effect of different degrees of PANi blended into PCL was investigated. Moreover, the effect of an array of aniline concentrations in coated fibers were studied. PCL/PANi blended solution with 2% PANi resulted in nanofibers with resistance of $10 \pm 4 \text{ M}\Omega/\text{cm}$. Fibers coated with 1% aniline concentration resulted in the core-shell fibers with of $50 \pm 8 \text{ k}\Omega/\text{cm}$. Increasing the number of plies of yarn to 3 plies resulted in a 3-fold reduction of the resistance. The twisted plied yarns were incorporated into fabric by stitching or weaving to demonstrate the stability of conductivity over mechanical forces. Both PANi blended and PANi coated yarns were found to be biodegradable in controlled environmental conditions. The use of PANi blended yarn as a biomaterial for tissue engineering and PANi coated yarns as a wearable electrode for capacitive sensors were demonstrated. The electromechanical behavior of PANi coated yarn is expected to provide inspiration for the production of highly sensitive strain sensors. This approach presents an early step on the way to the realization of all organic conductive biodegradable nanofibrous yarns for sustainable smart textiles.

Key words: Conductive polymers, nanofibrous yarns, biodegradable, electrospinning, polyaniline

Dedication

I dedicate my thesis to all my professors and doctors and scientists for the extensive knowledge you share with me. Your unselfish guidance increased my passion for nanotechnology.

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List of abbreviations

Abbreviation Description

PANi	Polyaniline
PCL	Polycaprolactone
CBNY	Conductive and biodegradable nanofibrous yarn
NY	Nanofiber yarn
SEM	Scanning electron microscope
FTIR	Fourier transform infrared
DSC	Differential scanning calorimetry
TGA	Thermogravimetric
PBS	Phosphate-buffered saline
ASTM	American Society for Testing and Material

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