

**DEVELOPMENT OF WEARABLE TRIBOELECTRIC
NANOGENERATORS USING OPTIMISED KNITTED
STRUCTURES**

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Degree of Master of Science

Department of Textile and Apparel Engineering

University of Moratuwa

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**Thesis/ Dissertation submitted in partial fulfillment of the requirements for the
degree Master of Science**

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DECLARATION

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Abstract

The rapid development of portable and wearable electronic devices has increased the demand for sustainable, low-maintenance, and lightweight power-supplying methods. One of the leading technologies in fabricating such power-supplying methods is triboelectric nanogenerators, which can be used to generate electricity using human motion. Triboelectric nanogenerator works on contact electrification and electrostatic induction, and a plethora of fabrication techniques have been used in the fabrication of triboelectric nanogenerators. One such technique is knitting technology, which is one of the major textile fabrication methods.

In this research, the effect of different knitting parameters and knitted structures on electrical performance of triboelectric nanogenerators were evaluated. The knitting parameters considered are stitch length and yarn count, and knitted structures considered are single jersey, rib, and interlock. Based on the results obtained, a wearable knitted sensor was fabricated using nylon 66 and silver as triboelectric surfaces. This sensor was able to identify finger bendings and tappings. Moreover, the durability of the electrical outputs of the knitted sensor was evaluated by studying the behavior of the conductive fabric's resistance when subjected to washing and abrading. The wearable performance of the triboelectric sensor was studied by measuring the air permeability and abrasion resistance of different sections of the sensor. Finally, the capability of using the sensing fabric for IoT applications was explained.

Keywords: Triboelectric nanogenerators, Wearable energy harvesters, Knitting

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ABBREVIATIONS

Abbreviation	Description
IoT	Internet of things
TENG	Triboelectric nanogenerator
ATP	Adenosine triphosphate
EMG	Electromagnetic generator
PEG	Piezoelectric generators
PZT	Lead-zirconate-titanate
PVDF	Polyvinylidene fluoride
DDEF	Distance-dependent electric-field
VCSTENG	Vertical contact separation mode TENG
LSTENG	Lateral sliding mode TENG
SETENG	Single electrode mode TENG
FSTENG	Freestanding triboelectric-layer TENG
Q_{sc}	Short circuit charge
I_{sc}	Short circuit current
V_{oc}	Open circuit voltage
SANES	Self-powered all-nanofiber-e-skin
OSAHS	Obstructive sleep apnea-hypopnea syndrome
PAN	Polyacrylonitrile
SEBS	Styrene-ethylene-butylene-styrene

SETY	Single-electrode triboelectric yarns
F-TENG	Fiber-shaped triboelectric nanogenerator
CNT	Carbon nanotube
3DB	Three-dimensional five-directional braiding
PDMS	polydimethylsiloxane
PTFE	polytetrafluoroethylene
HCOENP	Hydrophobic nanoparticles
PET	polyethylene terephthalate
FSTTN	Fully stretchable textile based TENG
PMM	Power management module
3DFIF-TENG	3D double-faced interlock fabric-based TENG
PU	polyurethane