Industry Day Theme 2 {SUSTAINABLE MEDICAL TECHNOLOGIES}

IIT DELHI INDUSTRY DAY 2019

SMART TEXTILES FOR MEDICAL APPLICATION

Viraj Somkuwar, Harsh Gupta, Bipin Kumar*

Textile Technology

Abstract

In recent times, applications like strain sensors, triboelectric nanogenerators etc. have been a topic of interest in field of textiles. We have been working on development of these sensors as the product developed from these can prove to be very cost-effective. We have been working with various textile materials exhibiting different properties on various platforms like knitting, weaving etc. to optimize our results according to our requirements in medical applications such as force sensor in Gait lab, respiration & motion sensors.

Introduction

TENG device can generate electrical signals from mechanical motion such as impact, sliding etc. Contact and separation between two layers having opposite tribopolarity induced potential difference, which drives electron to create signals.

Conductive textile filaments/yarns have been developed to be used in strain sensors. These conductive filaments/yarns when incorporated in fabrics can exhibit different resistance values when strain is applied due to variation in contact points and deformation. This variation in resistance can be quantified and can be used in various applications.

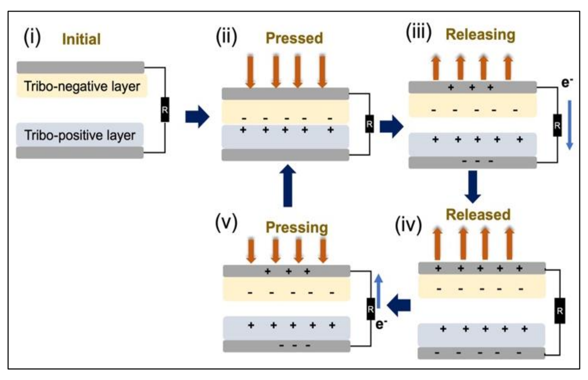

Figure 1 Schematic diagram of energy generation mechanism of TENG via vertical contact separation mode

Change in contact points & deformation of yarn structure

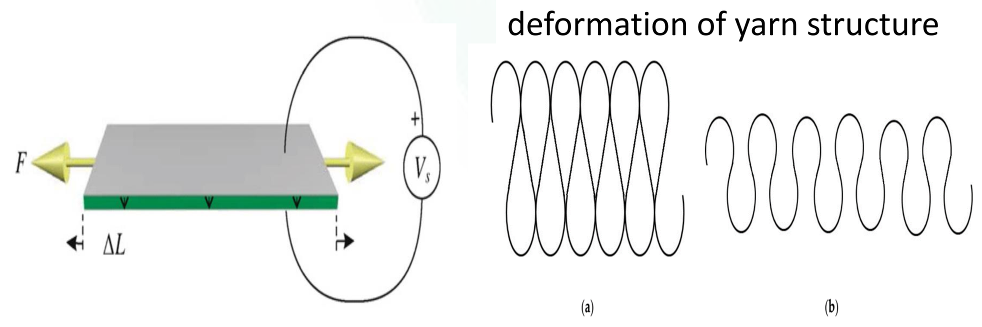

Figure 2 operating mechanism of strain sensor

Materials and Methods

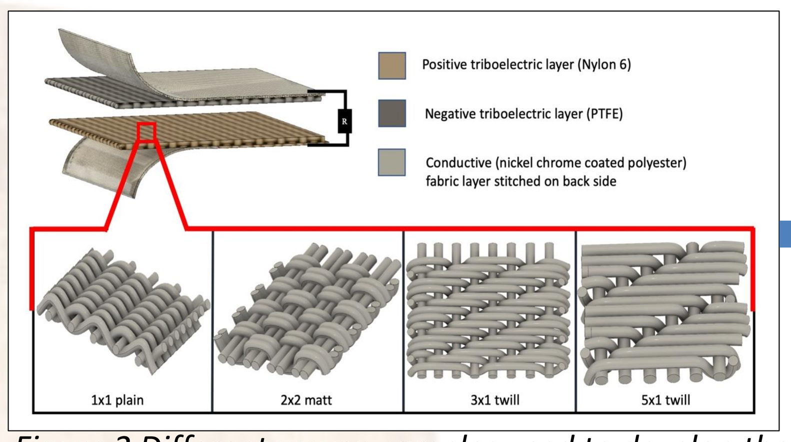

Figure 2 Different woven samples used to develop the TENG unit

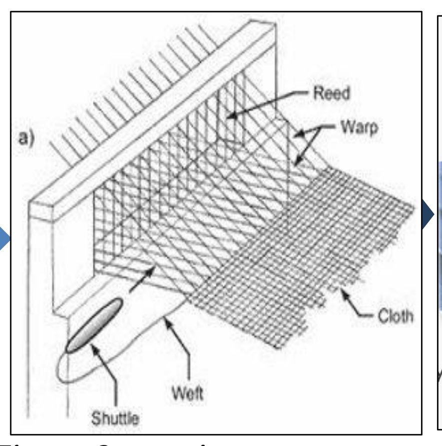

Figure 3 weaving process

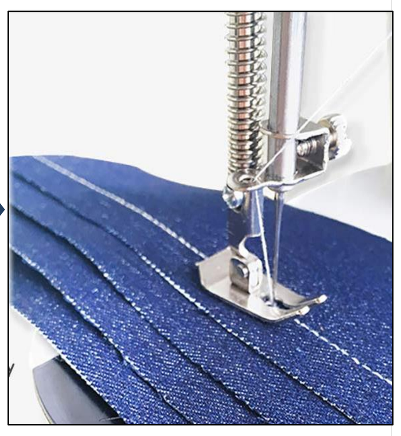

Figure 4 stitching process

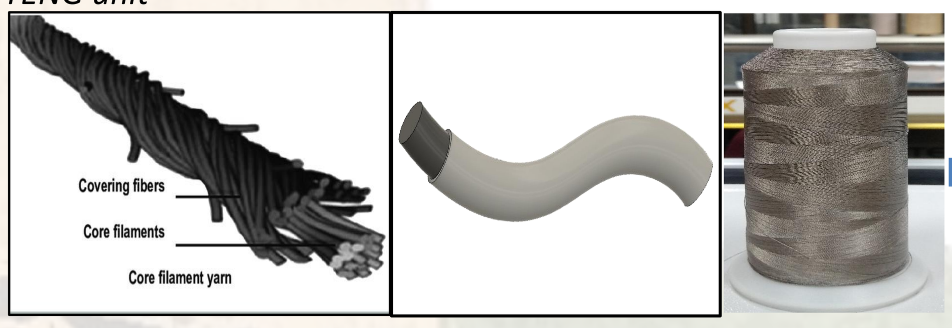

Figure 5 core spun & coated conductive yarn

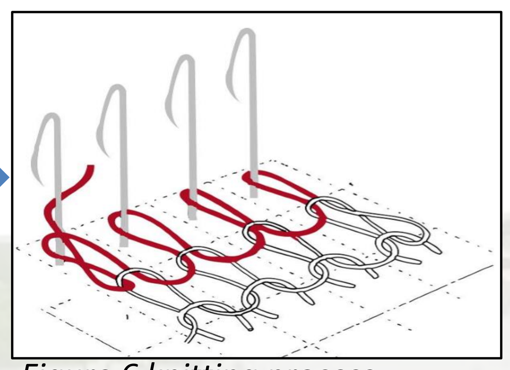

Figure 6 knitting process

Result

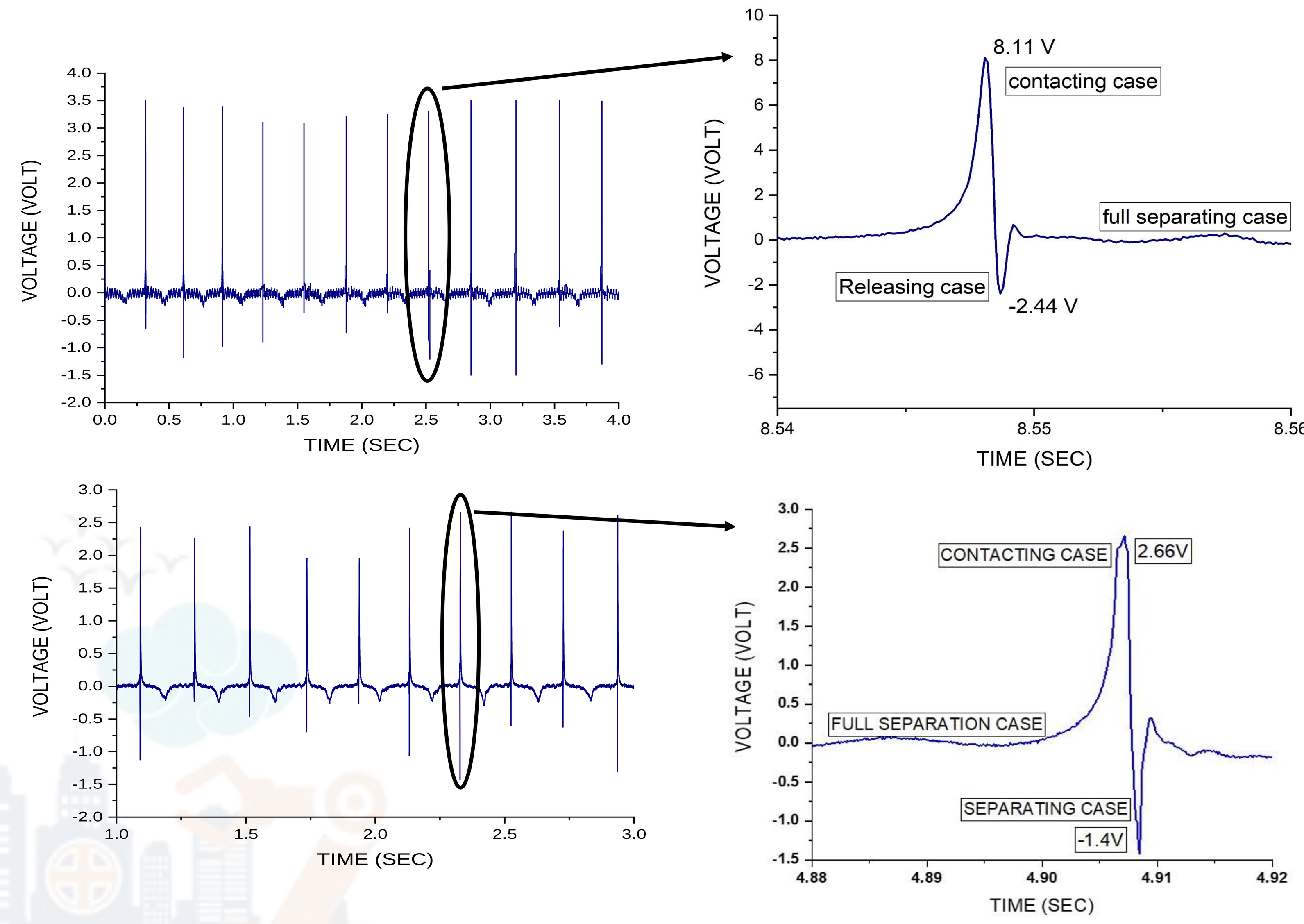

Figure 7 output voltage pattern for different structure on every cycle of contact separation

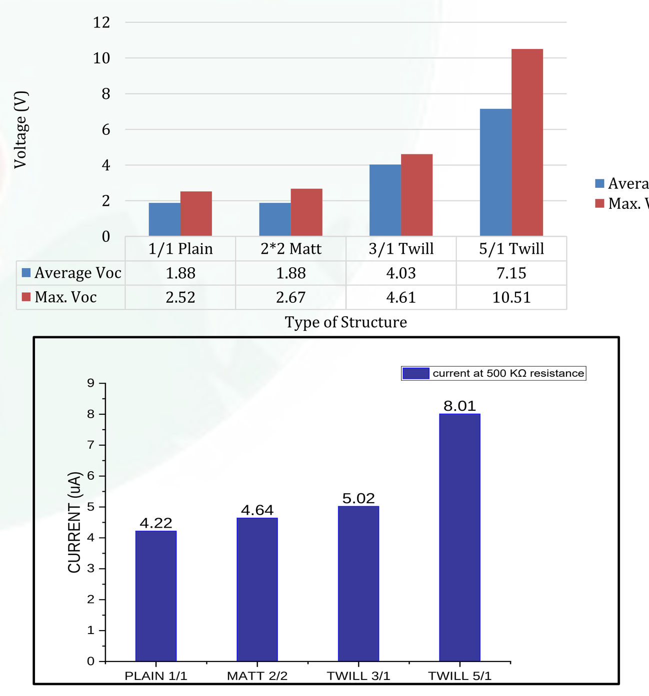

Figure 8 Instantaneous values of current & Voltage obtained for different weave structures

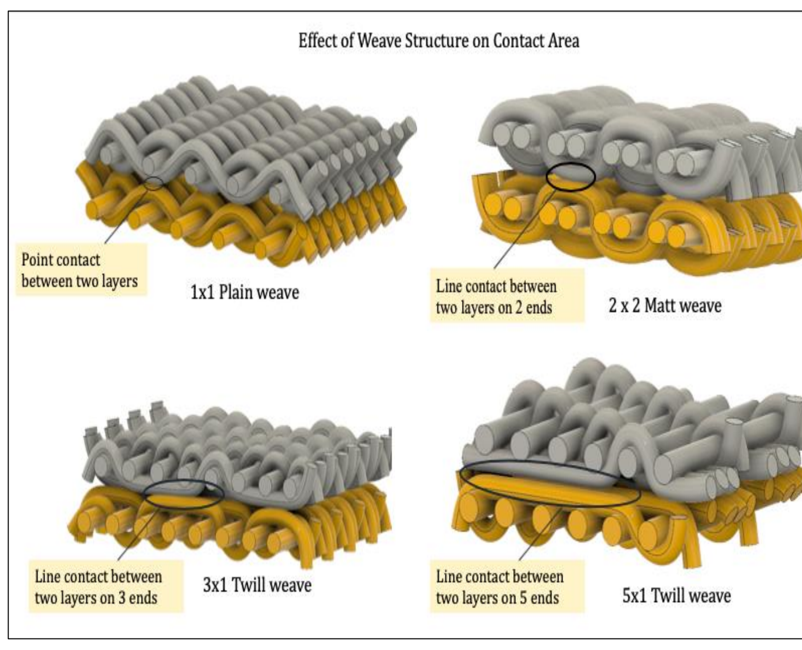

Figure 9 Variation of contact areas between the triboelectric woven fabric layers

Results from strain sensor

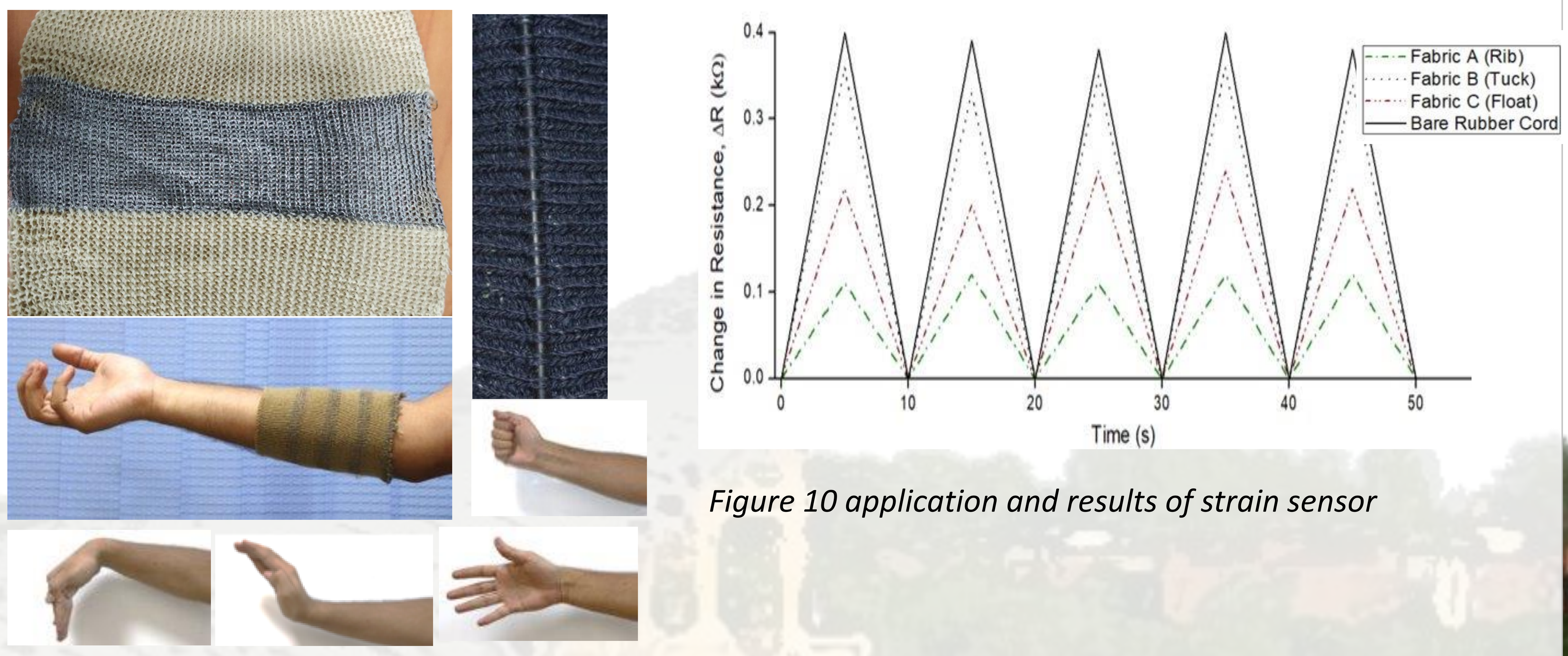

Figure 10 application and results of strain sensor

Conclusions

- Results with various structures shows different output signals for voltage and current. Higher contact area between layers shows increase in output.
- These principle can be implemented in force sensors used in GAIT analysis as well as pressure sensors for analysing walking pattern.
- Effect of extension on resistance properties of strain sensor shows its feasibility to use as a respiration motion sensor.

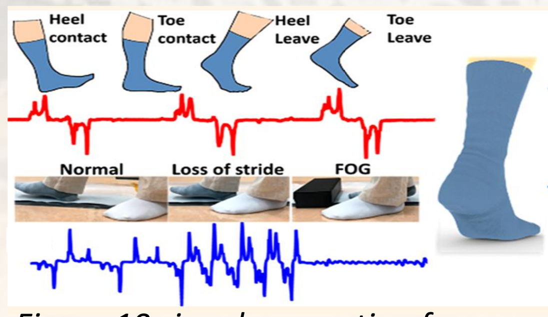

Figure 10 signal generation from walking pattern

Industrial Significance

- Cost effective indigenous solution for expensive medical diagnostic devices.

Technology Readiness Level:

Product optimization required.

References

1. Zhu, M., Shi, Q., He, T., Yi, Z., Ma, Y., Yang, B., ... & Lee, C. (2019). Self-powered and self-functional cotton sock using piezoelectric and triboelectric hybrid mechanism for healthcare and sports monitoring. *ACS nano*, *13*(2), 1940-1952.
2. Tangsirinaruenart, O., & Stylios, G. (2019). A Novel Textile Stitch-Based Strain Sensor for Wearable End Users. Materials, 12(9), 1469.
3. Dudem, Bhaskar, et al (2019) Wearable and durable triboelectric nanogenerators via polyaniline coated cotton textiles as a movement sensor and self-powered system, Nano Energy 55:305-315.
4. Hong, J.;Pan, Z.; ZheWang, Yao, M.; Chen, J.; Zhang, Y. A large-strain weft-knitted sensor fabricated by conductive UHMWPE/PANI composite yarns. Sensors and Actuators A 238 (2016) 307–316
5. Fan, Feng-Ru, Zhong-Qun Tian, and Zhong Lin Wang (2012) Flexible triboelectric generator, Nano energy 1.2:328-334.

Acknowledgement

The work was supported by Department of Textile Technology, IIT Delhi.