Tekirdağ Namık Kemal University
Çorlu Engineering Faculty
Textile Engineering Department

ICONTEX 2019

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PROCEEDINGS

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With Our Thanks…

**listed in alphabetical order*

Keynote Speakers

Prof. Dr. **Yaming JIANG**

Tianjin Polytechnic University, School of Textiles, China

Directionally Oriented Knitted Fabric Reinforced Composite Applications

Prof. Dr. **Xungai WANG**

Deakin University, Institute for Frontier Materials, Australia

Recent Research on Fibres and Textiles in Australia

2nd International Congress of Innovative Textiles, ICONTEX2019
Scientific Program

17 APRIL 2019

09:00-10:30	**HALL 2** **OPENING SESSION** Prof. Dr. Fatma Göktepe, Chairperson of Icontex2019 Vehbi Canpolat, Chairman of Textile Finishing Manufacturers Association of Turkey (TTTSD) Adil Nalbant, Chairman of Textile Machinery and Accessories Manufacturers Association (TEMSAD) Ahmet Öksüz, Chairman of İstanbul Textile and Raw Materials Exporters Association (İTHİB) İbrahim Pektaş, Deputy Chairman of Turkish Exporters Assembly (TİM) Prof. Dr. Bülent Eker, Vice-Rector of Tekirdağ Namık Kemal University		
10:30-11:00	**COFFEE BREAK**		
11:00-11:30	**HALL 2** **PLENARY SESSION Prof.Dr. Xungai Wang/ Recent Research on Fibres and Textiles in Australia**		
11:45-13:00	**HALL 1** **Textile Finishing** **Chairman: Assoc. Prof. Dr. A. Pedro SOUTO**	**HALL 2** **Technical Textiles** **Chairman: Prof. Dr. Bülent ÖZİPEK**	**HALL 3** **Yarn Spinning Technologies** **Chairman: Prof. Dr. Suat CANOĞLU**
11:45-12:00	5285-Investigation of Softness Performance of the Vegetable Oil Based Silicone Softeners /Ertuğrul Demir - **Onur Balcı** - Koray Pektaş	5430-Hematite as a Natural Filler in Nonwoven Coatings for Enhanced Sound Insulation Property **/İlhan Özen** - Gamze Okyay - Oğuz Demiryürek	5145-Dual-Core Yarns and Measurement of Twist for Dual-Core Yarns **/Nida Yıldırım** - Gamze Kılıç - Hüseyin Gazi Türksoy
12:00-12:15	5149-Design of a Recipe Using Polyol Based Wicking Agent for Better Wicking Performance of Polyamide 6.6 Seamless Garments **/Berdan Kalav** - Banu Uygun Nergis - Cevza Candan	5250-Effect of Segmentation of the Frequency Range on the Evaluation of Electromagnetic Shielding Effectiveness **/İlkan Özkan** - Abdurrahman Telli	5213-An Investigation on Wickability Properties of Denim Fabrics Made from Microfilament Core-Spun Yarns **/Esin Sarıoğlu** - Osman Babaarslan
12:15-12:30	5292-Steam Application During Laundering for Decreasing Wrinkling of Shirts /Hatice Açıkgöz Tufan - Umut Kıvanç Şahin - **Işıl Uslu Hergenç** - İlkan Erdem	5439-Innovative Laser Technology in Textile Industry: Cutting **/Yordanka P. Angelova**	5350-Influences of Core Draft Ratio on Physical Properties of Dual-Core Slub Yarns /Münevver Ertek Avcı - **Nida Yıldırım** - Hüseyin Gazi Türksoy
12:30-12:45	5227-Investigation of Combustion Characteristics of Fire-Off Treated Co/Pet Fabrics by Cone Calorimeter **/Raziye Atakan** - Gülay Özcan	5157-Compression Stockings with Cotton Components for Long Haul Flights **/Sena Cimilli-Duru** - Banu Uygun Nergis - Cevza Candan	5150-Performance of Denim Fabrics Produced by Using Core-Spun Yarns Containing Nische Elastomeric Filaments /Osman Babaarslan - **Hatice Kübra Kaynak** - F. Beyazgül Doğan - Serhat Karaduman
12:45-13:00	5286-Investigation of the Reusability of the Waste Caustic in the Bleaching Process of the Knitted Fabrics /Yılmaz Yıldız - **Fatoş Ceren Akıncı** - Koray Pektaş - Onur Balcı	5151-Developing Flame Retardant Curtain Fabrics Using Acrylic Coating Material Containing Huntit and Hydro-Magnesite Minerals /Oğuz Demiryürek - **Volkan Karadayı**	
13:00-14:00	**LUNCH**		
14:00-15:00	**HALL 1** **Nanotechnology Applications in Textiles** **Chairman: Prof. Dr. Nihal SARIER**	**HALL 2** **Technical Textiles** **Chairman: Prof. Dr. Özer GÖKTEPE**	**HALL 3** **Knitting & Nonwovens** **Chairman: Prof. Dr. Hale KARAKAŞ**
14:00-14:15	5257-Fabrication and Antibacterial Activity of Composite Peo/Pcl Electrospun Nanofibers **/Zarife Barbak** - Hale Karakaş - Abdülkadir Sezai Saraç - Canan Yağmur Karakaş - Azime Yılmaz	5189-Developing Stone-Wool Panels for Hydroponic Agriculture Applications **/Levent Onal** - Sabri Çamlıca	5147-Abrasion Properties of Warp Knitted Cut-Pile Upholstery Fabrics **/Emel Çinçik** - Selçuk Aslantaş
14:15-14:30	5299-Atmospheric-Pressure Plasma Spray Deposition of Silver/Hmdso Nanocomposite on Polyamide 6,6 with Controllable Antibacterial Activity /A Ribeiro - M Modic - U Cvelar - G Dinescu - B Mitu - A Nikiforov - C Leys - İ Kuchakova - M Vanneste - P Heyse - M Vrieze - A P Souto - **A Zille**	5431-Efficiency of Biodegradable Coated Nonwoven Structure with Controlled Fertilizer Release Property in Lettuce Growth Trials Under Drought Stress **/İlhan Özen** - Gamze Okyay - Abdullah Ulaş	5199-An Inovative Solution Approach for Carpet Pile Pull Out Problem **/Halil İbrahim Çelik** - Özkan Bozoğlan
14:30-14:45	5359-Green Reduction of Graphene Oxide Coated Polyamide Fabric Using Carob Extract **/Nergis Demirel Gültekin** - İsmail Usta - Bahattin Yalçın	5353-Development of Textile Conductive Fabric By Copper Metal Coating Approach for E-Textile Applications **/Zuhaib Hassan** - Ozgur Atalay - Fatma Kalaoglu	5343-Investigation of the Effect of Regional Sap&Pulp Distribution to Diaper Performance **/Ümit Gençtürk**
14:45-15:00	5449-How Nanofiber Alignment Affects Proton Conductivity Of Ionomer Nanofibrous Membranes/ **Aliakbar GHAREHAGHAJI**	5259-Static Electrical Charasteristics of Double Layered Woven Car Seat Fabrics **/Gonca Özçelik** Kayseri - Pelin Gürkan Ünal - Diren Mecit - Faruk Bozdoğan	5233-Structural Properties of Fabrics Made of Metal Yarns **/Nilşen Sünter Eroğlu** - Suat Canoğlu - Sevhan Müge Yükseloğlu
15:00-15:45	**COFFEE BREAK & POSTER SESSION**		
15:45-17:00	**HALL 1** **Textile & Fashion Design and Modelling** **Chairman: Prof. Dr. Ömer Berk BERKALP**	**HALL 2** **Functional & Smart Textiles** **Chairman: Prof. Dr. Xungai WANG**	**HALL 3** **Textile Testing & Quality Control** **Chairman: Prof. Dr. Lubos HES**
15:45-16:00	5260-Evaluation of Project Proposal Performance by Fuzzy Logic in Textile R&D Centers **/Can Ünal** - Ayşegül Kaya	5234-Design and Development of Thermally Enhanced Textile Nanocomposites Incorporated with Phase Change Material Nanowebs /Emel Önder Karaoğlu - **Nihal Sarıer**	5460- Theoratical Study of Tensile Properties of Directionally Oriented Knitted Fabrics/**Yaming Jiang**, He Xiang, Yexiong Qi, Liangsen Liu
16:00-16:15	5358-Modelling of Generation and Dissipation Charges of Static Electricity on Surface of Polymeric Textile Materials /G. Alisoy - F. Göktepe - Ö. Göktepe - **Hafız Alisoy**	5212-Research on Shape Memory Textiles Based on Origami Techniques **/Isabel Cabral** - António Pedro Souto	5202-Image Processing Applications on Yarn Characteristics and Fault Inspection **/Elif Gültekin** - Halil İbrahim Çelik - Lale Canan Dülger - Halil İbrahim Sünbül - Harun Kani
16:15-16:30	5175-Development of Strategies Regarding Circular Economy for Apparel Retailers **/Canan Sarıcam** - Nazan Okur - Eren Eralp - Cem Berke Alpak - Kubra Genc	5139-A New Generation Mattress Ticking: Meditation /Cem Güneşoğlu , **Müjgan Durmuş** ,Ülkü Seyhan, , Gözde Seven, Nurcan Biçer	5258-Performance Charasteristics of Sleeping Bags /Enes Nayman - Nilgün Özdil - **Gonca Özçelik Kayseri** - Gamze Süpüren Mengüç
16:30-16:45	5186-Exploring the Engagement of Consumers With Fashion Brands on Social Media **/Nazan Okur** - Canan Saricam - Akın Yıldırım - Sercan Koçal	5349-Soft Piezoresistive Sensors for Integration into Smart Wearables **/Derya Tama** - Pedro Gomes - Yu Yao - Antonio Pedro Souto - Helder Carvalho	5351-Investigation of the Fibre Loss Effect of Raised 3 Thread Fabric **/Ğassan Asker** - Eray Akkuş - İbrahim Arslan - Murat Sevilmiş - Koray Pektaş - Onur Balcı
16:45-17:00	5266-Fast Fashion and Slow Fashion **/Nazan Kalebek** - Tuğba Ozturk	VII	5268-Dimensional Stability of Woven Terry Towel Fabrics Produced by Hard Core-Spun Yarns /Mehmet Polat - Sıdıka Fidan Polat - **Esin Sarıoğlu** - Hatice Kübra Kaynak - Yasemin Korkmaz

18 APRIL 2019

09:00-09:30	**HALL 2** **PLENARY SESSION Prof.Dr. Yaming Jiang - Directionally Oriented Knitted Fabric Reinforced Composite Applications**		
09:45-11:00	**HALL 1** **Textile Chemistry&Sustainability** **Chairman: Prof. Dr. Habip DAYIOĞLU**	**HALL 2** **Functional & Smart Textiles** **Chairman: Prof. Dr. Yaming JIANG**	**HALL 3** **Weaving** **Chairman: Prof. Dr. Recep EREN**
09:45-10:00	5174-Development of a Sustainable Chemical Management Strategy Through Cleaner Production Techniques in an İntegrated Home Textile Mill /**Ozge Bayraktar** - Emrah Ozturk - Murat Yildirim - Mehmet Kitis	5352-Resistance Variation of Different Substrats Applied Conductive Ink by Screen Print Technique /**Pedro Gomes** - Derya Tama - Hélder Carvalho - António Pedro Souto	5387-Effect of Weaving Pattern and Yarn Density on the Surface Roughness of Woven Fabrics /H. Jaouani - D. Matsouka - **Savvas Vassiliadis** - K.S. Nikas
10:00-10:15	5331-Chemical Recycling of Textile Waste /**Bojana Voncina** - J Valh Volmajer - S Vajnhandl - A Majcen Le Marechal - A P Aneja - A Lobnik	5158-Design of a Plaster Containing Benzoyl Peroxide Loaded Microsponges to Support Acne Treatment /**Nihal Atabay** - Merih Sarışık - Sinem Karavana - Seda Rençber	5344-Physical and Thermal Comfort Properties of Woven Fabrics Produced from Hybrid Yarns /Gözde Ertekin - Mustafa Ertekin - **Arzu Marmaralı**
10:15-10:30	5235-Microfiber Waste Load Analysis in Denim Fabric Laundering Process /**Merve Erkoç** - Gürkan Özkarademir - Osman Babaarslan	5360-A Study on Knitting Performance and Fabric Properties of the Yarns Spun from Nano-Fibers /**Özer Göktepe** - F. Göktepe - S. Şenocak	5188-Utilization of Metallic Fibers in Textiles /**Müslüm Kaplan** - İsmail Borazan - M. Bünyamin Üzümcü
10:30-10:45	5251-Green Synthesis of Reactive Dyes for Inkjet Printing /**Saira Faisal** - Long Lin	5269-Production of Cotton Conductive Fabric by Polymerization of Pyrrole /**Ayse Genc** - Merve Erkoç - Nihan Karakaplan	5325-Development of Woven Fabrics With Electromagnetic Shielding by Quality Function Deployment Application /**Bilge Berkhan Kastacı** - H.Ziya Özek
10:45-11:00	5346-Influence of Chemical Reaction Conditions in P(St-Mma-Aa) Synthesis: Variation in Nanoparticle Size, Color and Deposition Methods /**Rui D.V. Fernandes** - Pedro Gomes - Andrea Zille - António Souto	5184-Modelling and Development of Smart, Solar Powered, Motorized Roller Blinds System Prototype /**Özge Bayraktar** - Hafiz Alisoy - Murat Yildirim	5288-Developing an Electronic Jacquard Sample Weaving Machine /**Müslüm Kaplan** - Deniz Mutlu Ala - Nihat Çelik
11:00-11.30	**COFFEE BREAK & POSTER SESSION**		
11:30-12:45	**HALL 1** **Dyeing** **Chairman: Prof. Dr. A. Merih SARIIŞIK**	**HALL 2** **Technical Textiles** **Chairman: Prof. Dr. Savvas VASSILIADIS**	**HALL 3** **Yarn Spinning Technologies** **Chairman: Prof. Dr. İsmail USTA**
11:30-11:45	5313-Antibacterial Potential Of Cotton Fabrics Dyed With İndigofera Tinctoria-Derived Dye /Diana Santiago - Helena P. Felgueiras - Gabriela Forman - **António P. Souto**	5103-Low Velocity Impact Behaviour of Carbon/Xps Sandwich Composites /Erdem Selver - **Gaye Kaya**	5152-The Production of Bcf Yarn and Machine Carpet from Recycled Polypropylene Yarns /**Şebnem Sözcü** - Cem Güneşoğlu - Mehmet Şakir Erboz - Azize İnce
11:45-12:00	5432-Novel Method for the Bleaching and Brightening of Indigo-Dyed and Sulphured-Dyed Textiles /**Huseyin Akbulut** - Deniz Gunes - Refik Gulbahar	5159-Investigating the Effect of an Antifouling Paint Applied on Polyamide 6.6 Fish Nets /**Korhan Şen** - Levent Çavaş - Ümit Halis Erdoğan	5347-Properties of Drawn Textured Polyester Yarns of Different Cross-Sectional Fibers /**Fatih Ahmet Özat** - Duygu Yılmaz - Mahmut Oğuz Kesimci - Özcan Özdemir
12:00-12:15	5243-Investigation of the Dyeability of Regenerated Cellulosic Fabrics With White Onion Peel in the Presence and Absence of Mordants /Rıza Atav - **Selma Soysal** - Erkan Çağlar - Fatma Yıldız	5183-Effect of Production Parameters on Acoustic and Abrasion Resistance Properties of Needlepunched Nonwovens /**Handan Palak** - Burçak Karagüzel Kayaoğlu	5342-Investigation of Core Covering Performance of Dual-Core Yarns with Image Processing Technique in Terms of Production Parameters /Gamze Kılıç - Bekir Yıldırım - **Sümeyye Üstüntağ** - Hüseyin Gazi Türksoy
12:15-12:30	5246-Determination of the Effect of Knitted Fabric Construction on Color in View of Right-First Time Dyeing /Rıza Atav - **Tuğçe Sena Horasan** - Alpaslan Bilgiç - Orhun Ek	5429-Effect of Plasma Treatment on Glass Fiber /Epoxy Resin Composite /**Aminoddin Haji** - Mohsen Hadizadeh - Elahe Ferasat - Delaram Movaghatian	5198-Investigation of Using New Generation Fibers on Properties of Melange Yarns /**Osman Yayla** - Hadi Samet Mumcu - Eyüp Ali Satıl - Hatice Nida Civan - Serkan Nohut
12:30-12:45	5187-Loop Dimensional Difference/Melange Appearance on Warp Knitted Towel Fabrics /**Tuğçe Töngüç** - Ahmet Ali Dildar - Barış Mancar - Melike Küçüker - Hasan Örtün	5102-Compressive Properties of Z-Fibre Reinforced 3D Composites /**Gaye Kaya** - Constantinos Soutis - Prasad Potluri	5155-Effect of Balloon Length on Yarn Tension Change During Unwinding of Yarns Including Lycra Component /**Özge Çelik** - Recep Eren
12:45-13:45	**LUNCH**		
13:45-14:45	**HALL 1** **Textile Finishing** **Chairman: Prof. Dr. Slah MSAHLI**	**HALL 2** **Ecology&Sustainability** **Chairman: Prof. Dr. Prof. Dr. Aliakbar GHAREHAGHAJI**	**HALL 3** **Textile Testing &Quality Control** **Chairman: Prof. Dr. Arzu MARMARALI**
13:45-14:00	5185-Optimization of Coating Process Parameters for Color Difference After Abrasion of Denim Fabrics by Using Taguchi Method /Hüseyin Gazi Türksoy - **Sümeyye Üstüntağ** - Münevver Ertek Avcı	5327-Ecological Textile Policy /**Habip Dayıoğlu**	5271-The Effect of Heat Transfer Conditions on Thermal Conductivity of Fabrics Determined by Various Testing Instruments /**Lubos Hes** - V. Bajzik - J. Pichova
14:00-14:15	5389-An Alternative Process Development to the Conventional Stone Wash in Net for Denim Garment Production /**Semra Kördüğüm** - E. Oğul - S. Ünlü - O Balcı	5164-Production of a Novel Polyoxometalate-Based Nanomaterials and Their Usage in Purification of Wastewater Containing Textile Dye Effuluents / **İlker Kandemir** - Hazal Oluk - Necip Atar	5210-Seam Slippage Behaviour in Woven Fabrics Obtained from Recycled Cotton Yarns and Blends /**Mihriban Kalkancı**
14:15-14:30	5284-The Improvement of the Fastness of Bifunctional Reactive Dyes Using Natural Bentonites in The Washing Processes /**Dilek Şarapnal** - Fatma Müzeyyen Parladı - Derya Denizhan	5253-A Review on Microplastics and Their Impact on Marine Environment /**Ilkan Erdem** - Banu Uygun Nergis - Seyhan Uygur Onbaşioğlu	5281-A General Overview on the Performance Features of Baby Diapers /**Gonca Özcelik Kayseri** - Esen Özdoğan - Aslı Demir
14:30-14:45	5207-Waterproof Breathable Functional Application for Polyester Fabric /**Erdal Gülcan** - Duygu Yılmaz - Figen Çetinoğlu - Koray Bükülmezer - Burcu Yılmaz Şahinbaşkan		5153-The Failure Mode and Effect Analysis of The Fabric Production in Karadeniz Knitted Fabric Factory /Vedat Özyazgan - Vassilya Uzun - **Mohammed Ahmed Shah**
14:45	**CLOSING CEREMONY** **DEPARTURE FOR BOSPHORUS TOUR & GALA DINNER**		

2nd International Congress of Innovative Textiles, ICONTEX2019
POSTER LIST
17 APRIL 2019 - 15:00 - 15:45 & 18 APRIL 11:00-11:30

P - 01	PRINTED ELECTRONIC GARMENT: CREATING NEW OPPORTUNITIES FOR TEXTILE AND ELECTRONIC INDUSTRIES	**Amine Hadj Taieb** - Slah Msahli - Faouzi Sakly
P - 02	COMPOSITE MATERIAL DESIGN TO BE USED FOR BUILDING ROOF AND SIDE WALLS WHICH OPTIMAL RATE OF WATER VAPOUR PERFORMANCE / MATERIALS THICKNESS	**Utkay Dönmez** - Hacer Nozoğlu - Murathan Sevim - Emrah Kaçmaz
P - 03	AN INNOVATIVE APPROACH WITH DEVELOPMENT OF AN IR REFLECTIVE-COLORED FABRICS FOR ROLLER BLINDS	**Habibe Gülben Selvi** - Murat Yıldırım
P - 04	NUMERICAL AND EXPERIMENTAL ANALYSIS OF WOVEN FABRIC IN OUT-OF-CENTER TENSILE LOADING	Željko Šomođi - **Snježana Brnada** - Emilija Zdraveva - Stana Kovačević
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SOFT PIEZORESISTIVE SENSORS FOR INTEGRATION INTO SMART WEARABLES

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Abstract
By the recent advances in intelligent textile applications, textile sensors have gained an important role and the interest in developing new sensor solutions has increased. Therefore, this study focused on developing new flexible pressure sensors based on piezoresistive materials, using different materials as electrodes, as well as different methods for joining the material layers. Within this context, Linqstat film and conductive silicone were taken as piezoresistive material. A silver-plated polyamide fabric, two kinds of conductive inks, aluminium foil and the conductive silicone were used as electrodes. To join the layers, ultrasonic welding, hot press and an oven were used as equipment. Although some samples failed to work as sensors, most of the sensors exhibited good performance.

Key Terms
Pressure sensors, Piezoresistive materials, Conductive fabric, Conductive ink, Conductive Silicone, Smart textiles

1. Introduction
The development in technology created a demand to bring together electronic technology and textiles, and caused a new research field showing up as smart textiles. As a common definition, this smart textiles are intelligent materials/systems that can sense and respond to the surrounding environment in a predictable and useful manner [1,2]. The basis of smart textiles concerns with textile-based sensors integrated mechanically and structurally into a textile.
The sensors investigated in this study are piezoresistive materials based soft pressure sensors. The construction of sensors are shown in Fig. 1 [3]. It contains three layers; the piezoresistive material is placed in the middle overlaid with electrodes by two sides for electrical connection.

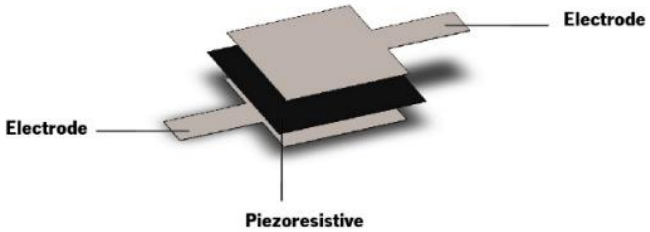


Fig. 16. The construction of pressure sensors

This research also focused on developing these soft pressure sensors using different materials as electrodes, as well as different methods for joining the material layers. In previous researches [4-6], some of those materials and applied methods were presented. This paper aims to present a brief of the conducted extensive study.

2. Experimental

2.1. Materials

The materials used to build pressure sensors are presented in Table I. Firstly, Linqstat film was taken as piezoresistive material. In order to determine the melting point of Linqstat, a DSC test was conducted and it was obtained as 123˚C. This was the restrictive value of the study working with high temperatures. During the research process, it was found out that conductive silicone, initially considered as conductive material for the electrodes, also behaves like a piezoresistive material. Based on this observation, new samples were constructed using conductive silicone as piezoresistive material. In order to improve the sensing capabilities, mixtures between conductive and non-conductive silicones were prepared in different concentrations and thicknesses.

Table I. Materials applied to make pressure sensors.

Piezoresistive Materials	Linqstat (Caplinq)
	Conductive silicone (Wacker ELASTOSIL® LR 3162 A/B)
Electrodes	Sn/Cu/Ag plated polyamide fabric: Zell by Statex
	Conductive silicone (Wacker ELASTOSIL® LR 3162 A/B)
	Conductive ink (DuPont PE 825 Silver Composite Conductor, DuPont PE 828 Silver Conductor)
	Aluminium foil
Side Materials	Thermoplastic web based on polyolefin (TW-1)
	Thermoplastic net based on polyolefin(TN-2)
	Primer (WACKER® PRIMER G 790)
	Nonconductive silicone (Wacker ELASTOSIL® LR 3003/50 A/B)

A silver-plated polyamide fabric, two kinds of conductive inks, aluminium foil and the conductive silicone were used as electrodes. The curing conditions of PE 825 and PE 828 were 120-140°C, 2-10 minutes and 60-100°C, 10-20 minutes in the oven, respectively. In order to improve the adhesion between Linqstat (as piezoresistive material) and conductive silicone (as electrode) a primer was used. Two different bonding materials were used to ensure adhesion between Linqstat and conductive fabric. The thermoplastic web (TW-1) has a melting temperature of 105-110 ºC whereas the thermoplastic net (TN-2) has a melting point of 78-88 ºC.

2.2. Methods

In order to assure mechanical stability of the sensors, without affecting electrical contact between layers, different methods for assembly the electrode and piezoresistive layers were used. Ultrasonic welding, hot press and oven were the equipment used for building the sensors. Plasma treatment was used to modify the surface of the piezoresistive materials and improve bonding. Plasma treatment can be used to induce surface texturization (creation of microroughness) increasing the possibility to get a better absorption and adhesion of finishing agents, stamping, inks [5]. The conductive inks were applied by brush painting technique and glass plates were used to avoid bubbles on the surface of conductive silicone and also to assemble the layers applying minimum pressure by glass plates that was overlaid. The change in, by pressure of all samples, were measured by a multimeter to obtain if the sample is functional as pressure sensor. A Hounsfield dynamometer producing 10 cycles of compression between 2 and 100 N at a speed set at 5 mm/min, being the sensor conditioned by a specific signal conditioning circuit to output a voltage as a function of compression force.

3. Results and Discussion

Table II presents a brief of all produced samples, explains the used materials, equipment and methods, the dimensions of samples as well as the used conditions, and as conclusion if the sensor is functional.

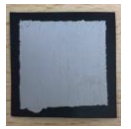
Sample 1, prepared by ultrasonic welding technique was functional, however the response was unstable due to the joining the layers only from the sides, inside the square there was no adhesion (Fig. 2 (a)). Samples 2 and 3 were prepared by welding in hot press. The sensors were both un-functional and it was thought that the change in the structure of piezoresistive material by the pressure/temperature combination in hot press might have been the reason. Samples 4 and 5 were prepared with conductive ink PE 825. Due to the properties of the ink, the sensors were not flexible and also the adhesion between layers was not good enough. In order to improve adhesion, plasma treatment was applied to the Linqstat film and the sample 6 was prepared. Better adhesion between layers was obtained, nevertheless the ink layer could be pulled off. The durability of the inks was found to be better on the samples with plasma treatment. There was low resistance between electrodes and all three sensors didn't behave as pressure sensors. The conductive ink PE 828, which is described by Dupont as more flexible, was used as electrode in sample 7 as well as in sample 8 but with the Linqstat applied plasma treatment. The sensors were more flexible but still they were not appropriate to be used as pressure sensors due to the low resistance and resistance changes between electrodes.

In sample 9, two masks made of carton were cut and put both sides of the Linqstat film in order to assure the silicone paste gained the desired dimensions and later the sample was overlaid by glass plates. The primer was sprayed on the Linqstat before the application. Despite all the effort, adhesion between layers could not be achieved. Therefore, an attempt to join the layers by welding with heat and pressure was performed; sample 10; however it ended up with destroying the Linqstat. After exploring the piezoresistive behaviour of conductive silicone, samples 11 and 12 were produced with conductive ink PE825 and PE 828, respectively. The samples presented cracks and bad adhesion between the ink and the silicon layers. Sample 13 was prepared with conductive silicone and conductive fabric and in order to perform the layout of the layers and give the dimensions of conductive silicone during curing, a mask was used and the sample was overlaid by glass plates as sample 9 and 10. It was an un-functional sensor; it seemed to have a short circuit. In order to control this, sample 14 was built using an aluminium foil instead of conductive fabric, which is a well-known highly conductive material. It was found that the sample was functional as a pressure sensor.

In sample 15, thermoplastic webs were placed on both sides of piezoresistive material to create an interface. Adhesion between layers was good, but the sensor was not functional, the behaviour was very unstable. Sample 16 and 17 were prepared same as sample replacing thermoplastic webs with thermoplastic nets. They were functional; sample 16 presented some hysteresis present. In sample 17, adhesion was good, and the sensor reacted to the pressure applied however, there was unstable response. Sample 18 was functional as pressure sensor but still there was some hysteresis present (Fig. 3 (a)). In sample 19, there was some hysteresis like sample 18; however, it presented the highest resistance. It seems that sample 19 (Fig. 3 (b)) was the best pressure sensor obtained in this research.

Table II. The details of produced sensors

Sample	Materials	Method	Equipment	Sample Dimension	Conditions	Image	Sensor Situation
1	Linqstat + Conductive fabric	Welding with ultrasound	Ultrasonic welding machine	Dim. of piezoresistive film: 30 x 30 mm^2 - Dim. of electrodes: 35 x 30 mm^2 Sensor area: 25 x 25 mm^2	Ultrasound power: 100% Sewing speed: 14 dm/min Roller width: 4 mm		Pressure sensor was functional
2	Linqstat + Conductive fabric	Welding with heat and pressure	Hot press welding machine	Dim. of piezoresistive film: 25 x 25 mm^2 - Dim. of electrodes: 20 x 20 mm^2	Temperature:120°C Time: 10 sec. Pressure: 3,5 bar		Pressure sensor was non-functional
3	2 layers of Linqstat + Conductive fabric	Welding with heat and pressure	Hot press welding machine	Dim. of piezoresistive film: 25 x 25 mm^2 - Dim. of electrodes: 20 x 20 mm^2	Temperature:120°C Time: 10 sec. Pressure: 3,5 bar		Pressure sensor was non-functional
4	Linqstat + Conductive Ink (PE 825)	Brush painting + curing in the oven	Oven	Dim. of piezoresistive film: 25 x 25 mm^2 - Dim. of electrodes: 20 x 20 mm^2	Temperature:100°C Time: 10 min.		Pressure sensor was non-functional
5	Linqstat + Conductive Ink (PE 825)	Brush painting + curing in the oven	Oven	Dim. of piezoresistive film: 25 x 25 mm^2 - Dim. of electrodes: 20 x 20 mm^2	Temperature:120°C Time: 10 min.		Pressure sensor was non-functional
6	Linqstat + Conductive Ink (PE 825)	Plasma treatment + Brush painting + curing in the oven	Plasma equipment + Oven	Dim. of piezoresistive film: 25 x 25 mm^2 - Dim. of electrodes: 20 x 20 mm^2	<u>Plasma:</u> Passages: 5 times each side Speed: 4 m/min Dosage: 41,7 J/m^2 Temperature:120°C Time: 10 min.		Pressure sensor was non-functional
7	Linqstat + Conductive Ink (PE 828)	Brush painting + curing in the oven	Oven	Dim. of piezoresistive film: 25 x 25 mm^2 - Dim. of electrodes: 20 x 20 mm^2	Temperature:80°C Time: 20 min.		Pressure sensor was non-functional

8	Linqstat + Conductive Ink (PE 828)	Plasma treatment + Brush painting + curing in the oven	Plasma equipment + Oven	Dim. of piezoresistive film: 25 x 25 mm^2 - Dim. of electrodes: 20 x 20 mm^2	<u>Plasma:</u> Passage: 5 times each side Speed: 4 m/min Dosage: 41,7 J/m2 Temperature:80°C Time: 20 min.		Pressure sensor was non-functional
9	Linqstat + Conductive silicone (as electrode) + Primer	Spraying the primer + Compressing between 2 glass plates + Curing in the oven	Oven	Dim. of piezoresistive film: 30 x 30 mm^2 - Dim. of electrodes: 20 x 20 mm^2	Temperature:120°C Time: 30 min.		Adhesion couldn't be achieved
10	Linqstat + Conductive silicone (as electrode) + Primer	Spraying the primer + Compressing between 2 glass plates + Curing in the oven + Welding with heat and pressure	Oven + Hot press welding machine	Dim. of piezoresistive film: 30 x 30 mm^2 - Dim. of electrodes: 20 x 20 mm^2	Temperature:120°C Time: 30 min. <u>Hotpress:</u> Temperature:120°C Time: 10 sec. Pressure: 3,5 bar		The sensor was destroyed
11	Conductive silicone (as piezo-resistive) + Conductive Ink (PE 825)	Brush painting + curing in the oven	Oven	Dim. of electrodes: 25 x 25 mm^2	Temperature:120°C Time: 10 min.		Pressure sensor was non-functional
12	Conductive silicone (as piezo-resistive) + Conductive Ink (PE 828)	Brush painting + curing in the oven	Oven	Dim. of electrodes: 25 x 25 mm^2	Temperature:80°C Time: 10 min.		Pressure sensor was non-functional

13	Conductive silicone (as piezo-resistive) + Conductive fabric	Compressing between 2 glass plates + Curing in the oven	Oven	Dim. of piezoresistive film: 30 x 30 mm^2 - Thickness: 2mm Dim. of electrodes: 25 x 100 mm^2	Temperature:120°C Time: 30 min.		Pressure sensor was non-functional
14	Conductive silicone (as piezo-resistive) + Aluminium foil	Compressing between 2 glass plates + Curing in the oven	Oven	Dim. of piezoresistive film: 30 x 30 mm^2 - Thickness: 2mm Dim. of electrodes: 25 x 100 mm^2	Temperature:120°C Time: 30 min.		Pressure sensor was functional
15	Linqstat + Thermoplastic web TW-1 + Conductive fabric	Welding with heat and pressure	Hot press welding machine	Dim. of piezoresistive film: 30 x 30 mm^2 - Dim. of electrodes: 25 x 70 mm^2 Dim. of thermop. Web: 25 x 205mm^2	Temperature:110°C Time: 10 sec. Pressure: 3,5 bar		Pressure sensor was non-functional
16	Linqstat + Thermoplastic net TN-2 + Conductive fabric	Welding with heat and pressure	Hot press welding machine	Dim. of piezoresistive film: 30 x 30 mm^2 - Dim. of electrodes: 25 x 70 mm^2 Dim. of thermop. Web: 25 x 25 mm^2	Temperature:85°C Time: 10 sec. Pressure: 3,5 bar		Pressure sensor was functional
17	Linqstat + Thermoplastic net TN-2 + Conductive fabric	Welding with heat and pressure	Hot press welding machine	Dim. of piezoresistive film: 30 x 30 mm^2 - Dim. of electrodes: 25 x 70 mm^2 Dim. of thermop. Web: 25 x 25 mm^2	Temperature:110°C Time: 10 sec. Pressure: 3,5 bar		Pressure sensor was functional
18	Linqstat + Thermoplastic web TW-1 + Conductive fabric	Compressing between 2 glass plates + Curing in the oven	Oven	Dim. of piezoresistive film: 30 x 30 mm^2 - Dim. of electrodes: 25 x 70 mm^2 Dim. of thermop. Web: 25 x 205mm^2	Temperature:110°C Time: 10 mins.		Pressure sensor was functional
19	Linqstat + Thermoplastic web TN-2 + Conductive fabric	Compressing between 2 glass plates + Curing in the oven	Oven	Dim. of piezoresistive film: 30 x 30 mm^2 - Dim. of electrodes: 25 x 70 mm^2 Dim. of thermop. Web: 25 x 25 mm^2	Temperature:110°C Time: 10 mins.		Pressure sensor was functional

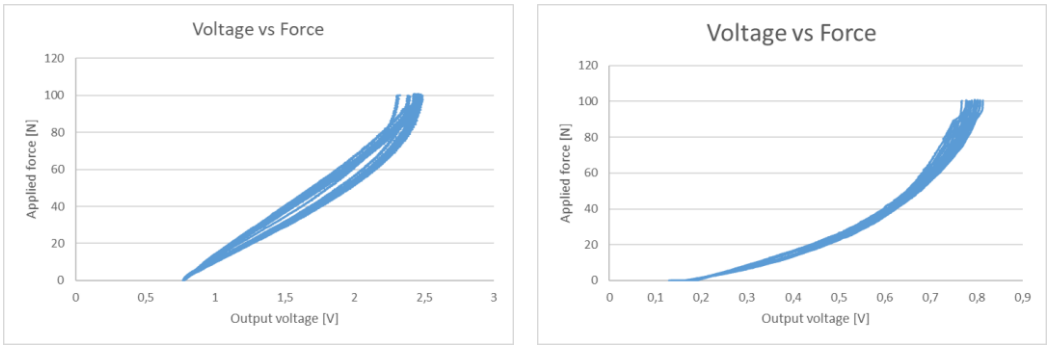


Fig. 2. Voltage vs force output for 10 cycles at 50 mm/min, max. force of 100 N, (a) sensor prepared using ultrasonic welding and (b) conductive silicone (piezoresistive) with conductive fabric.

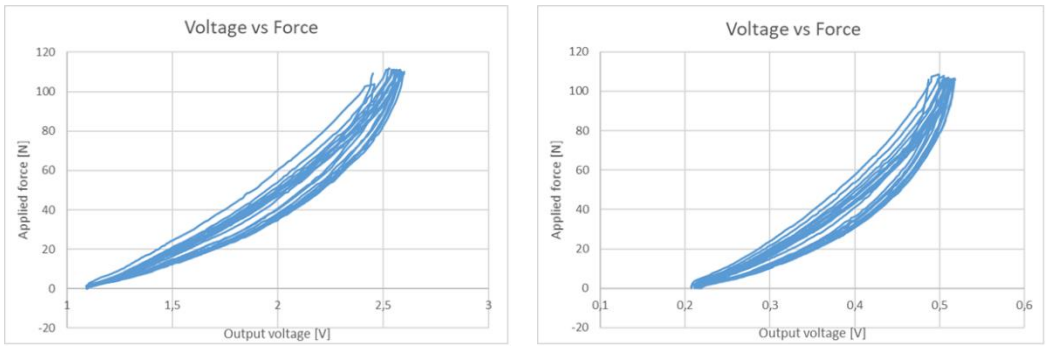


Fig. 3. Voltage vs force output for 10 cycles at 50 mm/min, max. force of 100 N, (a) Sample 18, sensor prepared using thermoplastic web TW-1 and (b) Sample 19, sensor prepared using thermoplastic net TN-2.

In an ideal graphic for force and extension, the lines should overlap in every cycle. As it can be seen in Fig. 2 and Fig. 3, the graphs presented deviations for the samples. That means, the samples had losses in recovering capacity in every cycle. Fig. 3 (a), presents the graph belonged the conductive silicone used as piezoresistive material. In this sample, the conductive fabric was used as electrodes, but there was not any effort to achieve adhesion between the layers. The electrodes only placed on two sides of conductive silicone and the test in the Hounsfield dynamometer was performed. The resistance was high in this sample similar with sample 19. However, the adhesion between layers in sample 19 could be achieved and the resistance was the highest.

Conclusions

This paper presents the improvement in producing soft pressure sensors based on piezoresistive materials in order to integrate textiles. Different materials were used as piezoresistive material, as electrodes as well as the side materials, and different assembly methods were used. Adhesion between the layers seems to be sufficient in most of the produced samples, however in some of them, the resistance was very low and/or the response to the applied pressure was unstable. In samples 15-19, thermoplastic bonding materials were used and it seemed, according to the obtained results, that they were adequate to produce the sensors. The best sensor was obtained with thermoplastic net due to its even structure, it showed to sense the pressure evenly. It can be concluded that sample 19 was the best-obtained soft pressure sensor and can be integrated into the textiles and/or sport equipment.

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References
1. Schwartz, M. (Ed.), Encyclopedia of Smart Textiles, Wiley, New York, ISBN 0-471-17780-6, 2002.
2. Bosowski, P., Hoerr, M., Mecnika, V., Gries, T. and Jockenhövel, S., 2015, Electronic Textiles, Smart Fabrics and Wearable Technology: Design and manufacture of textile-based sensors, Woodhead Publishing, England, 307 p.
3. Carvalho H, Yao Y and Gonçalves M, Flexible force sensors for e-textiles, 17th World Textile Conference AUTEX 2017- Textiles - Shaping the Future, Conf. Series: Materials Science and Engineering 254, 2017.
4. Tama, D, Gomes, P, Yao, Y, Abreu, M.J, Souto, A P, Carvalho, H Developing Smart Body Protector For Sports Karate, Proc. of the XIVth International Izmir Textile and Apparel Symp, 2017, Izmir, Turkey
5. Gomes P, Tama D, Yao Y, Abreu MJ, Souto AP and Carvalho H, Development of pressure sensors for smart textiles, IOP Conference Series: Materials Science and Engineering, 2018, 460 (1), 012024
6. Carvalho H, Tama D, Gomes P, Abreu MJ, Yao Y and Souto AP, Flexible piezoresistive pressure sensors for smart textiles, IOP Conference Series: Materials Science and Engineering, 2018, 459 (1), 012035

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