

H. Wang, D. Zhou and J. Cao, "Development of a Skin-Like Tactile Sensor Array for Curved Surface," in *IEEE Sensors Journal*, vol. 14, no. 1, pp. 55-61, Jan. 2014.

doi: 10.1109/JSEN.2013.2279394

Abstract: In this paper, we develop a skin-like tactile sensor array to measure the contact pressure of curved surfaces. The sensor array is laminated into a thin film 3 mm in thickness and can easily be wrapped around a pencil without damaging its skin-like structure. So far, we have achieved the array containing 8×16 sensor elements. Its spatial resolution is 1 element per 9 mm^2 area and it can measure the pressure up to 360 kPa. The sensor-array patch contains three layers. The upper and lower layers are polydimethylsiloxane (PDMS) thin films embedded with the conductor strips formed by PDMS-based silver nanowires (AgNWs) networks. The middle layer is formed by the mixing of nickel powder with liquid PDMS for contact force measurement. Experimental tests have demonstrated that conductor strips on the upper layer can maintain their resistances $\sim 23 \Omega$ with increase when the tensile strain is up to 50%. Noted is the conductor made with carbon nanotubes can keep its conductivity unchanged for up to only 40% tensile strain. Through fatigue tests, it is observed that the measured AgNWs/PDMS conductor strip exhibits low and stable resistances. This is one of the most desired behaviors of the stretchable interconnects for signal transmission. The integrated sensor system can successfully measure the contact pressure induced by objects of different shapes. It can be applied on curved or non-planar surfaces in robots or medical devices for force detection and feedback.

keywords: {carbon nanotubes;internal stresses;nanowires;polymer films;pressure measurement;sensor arrays;silver;tactile sensors;Ag;PDMS-based silver nanowires networks;carbon nanotubes;conductivity;conductor strips;contact;curved surface;fatigue tests;liquid PDMS;nickel powder;polydimethylsiloxane thin films;resistances;sensor-array patch;signal transmission;size 3 mm;skin-like tactile sensor array;spatial resolution;stretchable interconnects;tensile strain;thin film;Arrays;Conductors;Electrodes;Piezoresistance;Tactile sensors;PDMS;Tactile sensor array;conductive elastomer;curved surface;silver nanowires interconnects},

URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=6584718&isnumber=6650036>

D. Chen, M. Hang, K. Chen, K. Brown and J. X. J. Zhang, "Piezoelectric PVDF thin films with asymmetric microporous structures for pressure sensing," *2015 IEEE SENSORS*, Busan, 2015, pp. 1-4.

doi: 10.1109/ICSENS.2015.7370649

Abstract: We demonstrate that porous Polyvinylidene fluoride (PVDF) film can be used as a flexible piezoelectric pressure sensor with high sensitivity. Asymmetric porous structure is developed to promote larger collecting area and aligned poling direction. Film structure can be controlled by dispersing micro-scale pores in a polymer matrix with a dense top layer. Piezoelectric output is enhanced by optimization of PVDF micro-structure and electromechanical coupling efficiency. The sensitivity to pressure increased three folds with a designed three-dimensional asymmetric porous structure as compared to the bulk film without such porous structures. Direct film deposition on large size surface and pore-formation on electrode surfaces enable efficient and reliable PVDF piezoelectric sensor.

keywords: {microsensors;optimisation;piezoelectric materials;piezoelectric transducers;polymers;porous materials;pressure measurement;pressure sensors;thin film sensors;asymmetric microporous structure;direct film deposition;electrode;electromechanical coupling efficiency;flexible piezoelectric pressure sensor;microscale pore dispersion;optimization;piezoelectric PVDF thin film sensor;polymer matrix;pore-formation;porous polyvinylidene fluoride film;three-dimensional asymmetric porous structure;Biomembranes;Films;Polymers;Sensitivity;Solids;Surface impedance;Surface morphology;Piezoelectricity;Porous Structure;Pressure Sensor},

URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=7370649&isnumber=7370096>

J. J. Davenport, M. Hickey, J. P. Phillips and P. A. Kyriacou, "A fiberoptic sensor for tissue carbon dioxide monitoring," *2015 37th Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC)*, Milan, 2015, pp. 7942-7945.

doi: 10.1109/EMBC.2015.7320234

Abstract: We present a new fiberoptic carbon dioxide sensor for transcutaneous and mucosa (indwelling) blood gas monitoring. The sensor is based on optical fluorescence of molecules sensitive to pH changes associated with dissolved CO_2 . A three layer chemical coating was dip-coated onto the distal tip of an optical fiber (600 μm core radius). It contained the 50mg/ml 'polym H7', a coating polymer bonded to a fluorescence indicator dye, along with 125mg/ml of the transfer agent tetraoctylammonium hydroxide (TONOH). Light from a blue (460 nm) LED was launched into the fiber to excite the sensing film. The sensing film fluoresced green (530 nm), the intensity of which decreased in the presence of CO_2 . The sensor was tested in vitro, finding a correlation between change in fluorescence (in AU) and aqueous CO_2 concentration with a minimum detection threshold of 40%. The sensor is being developed for medical applications where its small size and ability to continuously monitor the partial pressure of CO_2 (PCO_2) will make it an extremely useful diagnostic tool.

keywords: {biological tissues;blood;carbon compounds;dip coating;fibre optic sensors;fluorescence;patient monitoring; CO_2 ;chemical coating;detection threshold;dip coating;fiberoptic sensor;mucosa blood gas monitoring;optical fluorescence;pH changes;tetraoctylammonium hydroxide;tissue carbon dioxide monitoring;transcutaneous blood gas monitoring;Fluorescence;Light emitting diodes;Monitoring;Optical fiber sensors;Optical fibers;Photonics},

URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=7320234&isnumber=7318236>

T. H. N. Dinh, P. Y. Joubert, E. Martincic and E. Dufour-Gergam, "Polymer-based flexible capacitive pressure sensor for non-invasive medical monitoring applications," *2014 IEEE International Symposium on Medical Measurements and Applications (MeMeA)*, Lisboa, 2014, pp. 1-5.

doi: 10.1109/MeMeA.2014.6860070

Abstract: In this paper, the design, the fabrication and the electromechanical characterization of polymer-based flexible pressure sensor are presented. This kind of sensors is developed for the non-invasive monitoring of pressure/force distributions that is required in many medical applications such as the monitoring of plantar pressures or chronic venous disorder treatments. The sensors considered in this paper are of a capacitive type. They are composed of two millimetric copper electrodes, separated by polydimethylsiloxane (PDMS) dielectric layers and deposited on a Kapton substrate. A study of the deformation of PDMS thin films under normal stress is carried out by finite element computations as well as experiments. This study points out a sensor design optimization parameter, the form ratio of the indented PDMS layer, which is used to design and fabricate capacitive micro-sensors samples. Preliminary electromechanical characterizations of realized

sensor samples validate the approach. Under a 10 N normal stress, the sensitivity of 9 square mm sensors varies from 3% up to 17% in capacitive change, according to the chosen form ratio of the used PDMS layer.

keywords: {biomedical equipment;capacitive sensors;finite element analysis;microsensors;patient monitoring;patient treatment;pressure measurement;pressure sensors;Kapton substrate;PDMS dielectric layer;PDMS thin film;capacitive microsensors sample;chronic venous disorder treatment;electromechanical characterization;finite element computation;millimetric copper electrode;noninvasive force distribution monitoring;noninvasive medical monitoring;noninvasive pressure monitoring;plantar pressure;polydimethylsiloxane dielectric layer;polymer-based flexible capacitive pressure sensor;sensor design optimization parameter;Capacitance;Electrodes;Fabrication;Films;Force;Robot sensing systems;Sensitivity;PDMS;capacitive pressure sensor;electro-mechanical characterizations;film transfer;flexible sensor},

URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=6860070&isnumber=6860015>

M. Sloma, D. Janczak, G. Wroblewski, A. Mlozniak and M. Jakubowska, "Graphene applications with printed electronics technology," *2013 European Microelectronics Packaging Conference (EMPC)*, Grenoble, 2013, pp. 1-3.

Abstract: Superior properties of nanomaterials were utilized by the authors in new type of polymer compositions, for emerging technology - printed electronics. This is a new trend in production of electronic devices, providing ability to manufacture low-cost and disposable electronic circuits using well-known printing techniques such as screen printing, roll-to-roll and ink-jet. The use of nanostructures and polymer compositions filled them are topic of interest in fabrication of new type printed electronics circuits, dedicated to transparent electrodes, elastic displays and photovoltaics, various types of sensors (pressure, temperature, biochemical) and in textronics. Paper presents authors achievements in the field of printed composite films containing graphene nanoplatelets. Our goal was to produce a resistive and conductive layers containing graphene with the use of screen printing and spray coating techniques. First step of these investigations was to elaborate a polymer compositions filled with graphene nanoplatelets. Second step was to adjust rheology and printing process parameters to obtain homogeneous, low resistivity layers, in some cases exhibiting high optical transmittance. Elaborated materials can be used for production of thick film hybrid microsystems. Printed electroluminescent structures fabricated with printed transparent graphene electrode are one of current authors achievements. Potential applications of these layers seems to be very promising.

keywords: {graphene;ink jet printing;nanostructured materials;printed circuits;electronic circuits;graphene applications;ink-jet;nanomaterials;polymer compositions;printed electroluminescent structures;printed electronics technology;roll-to-roll;screen printing;spray coating techniques;thick film hybrid microsystems;graphene;nanomaterials;printed electronics;sensors;transparent electrodes},

URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=6698662&isnumber=6698588>

P. C. Wang, W. K. Lin, S. Y. Hung and H. J. Lu, "Pressure-dependent variable resistors based on porous polymeric foams with conducting polymer thin films in situ coated on the interior surfaces," *2011 6th International Microsystems, Packaging, Assembly and Circuits Technology Conference (IMPACT)*, Taipei, 2011, pp. 63-66.

doi: 10.1109/IMPACT.2011.6117274

Abstract: Pressure-dependent variable resistors were fabricated by coating conducting polymer thin films on the interior surfaces of porous polyurethane (PU) foams with thickness ranging from 1 mm to 5 mm. To coat conducting polymer thin films on the interior surfaces of the porous PU foams, the PU foams were first immersed in 1 M aqueous camphorsulfonic acid (HCSA) solution containing 0.44 M of aniline (monomer solution) and then transferred to another 1 M aqueous camphorsulfonic acid solution containing 0.1 M of ammonium peroxydisulfate (oxidant solution). After the polyaniline (PANI) deposition process by in situ oxidative chemical polymerization of aniline on the interior surfaces of the porous PU foams, the non-conductive PU foams became all-polymer conductive composites. The formation of PANI thin films on the interior surfaces of the porous PU foams was confirmed by optical microscopy and scanning electron microscopy (SEM) studies, which showed that no bulk PANI was found to block the porous interstitial space of PU foams after the PANI deposition process. When a PANI-treated conductive PU foam was sandwiched between two pieces of plastic electrodes based on poly(ethyleneterephthalate) (PET) substrates coated with commercially available poly(3,4-ethylenedioxythiophene) doped with poly(styrenesulfonate) (PEDOT:PSS), the whole assembly could act as an all-polymer pressure sensor. By varying the size and thickness of the all-polymer PU-based pressure devices, the responsive ranges can be adjusted for different applications with different applied pressure ranges. With the incorporation of a polymeric cushion as the mechanical buffer layer around the conductive PU composite, the dynamic pressure-responsive range could be further increased. Compared to our previous work, the all-polymer pressure sensors described in the present work showed greater reproducibility when subject to repetitive cycling tests and exhibited greater continuous linear response range.

keywords: {conducting polymers;flexible electronics;optical microscopy;polymer foams;polymerisation;pressure sensors;resistors;scanning electron microscopy;thin films;all-polymer pressure sensor;ammonium peroxydisulfate;aqueous camphorsulfonic acid solution;conducting polymer thin films;dynamic pressure-responsive range;linear response range;mechanical buffer layer;optical microscopy;oxidative chemical polymerization;polyaniline deposition;polymeric cushion;porous polymeric foams;pressure-dependent variable resistors;repetitive cycling tests;scanning electron microscopy;size 1 mm to 5 mm;Chemicals;Electrodes;Polymers;Positron emission tomography;Robot sensing systems;Substrates;Surface treatment},

URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=6117274&isnumber=6117151>

L. Ventrelli, L. Beccai, V. Mattoli, A. Menciasci and P. Dario, "Development of a stretchable skin-like tactile sensor based on polymeric composites," *2009 IEEE International Conference on Robotics and Biomimetics (ROBIO)*, Guilin, 2009, pp. 123-128.

doi: 10.1109/ROBIO.2009.5420644

Abstract: This paper presents the design, fabrication and characterization of a novel tactile skin-like sensor with the capability of detecting at the same time external mechanical stimuli like pressure and shear strain and that possesses some of the intrinsic properties of human skin, like extensibility, flexibility and compliance. The proposed sensor is resistive based and integrates two sensing parts built by means of electrically conductive polymer composites and elastic metallic thin films. The final prototype consists of a 1.5 mm silicone-Carbon Black (at 23.6%) layer on which a stretchable 90 nm Au thin film is deposited by providing a 20% bidirectional substrate stretching before Au deposition. Compression tests showed high values (70 k Ω -80 k Ω) of the electrical resistance, that decreases quite regularly with the pressure (in the range of 0 N/mm²-0.16 N/mm²). In parallel, from shear strain testing, a low range of electrical resistance (20 Ω -70 Ω) from the extension and release phase was measured having a quite regular trend, increasing with the applied strain which reached 14%. The preliminary experimental analysis indicates that the new tactile skin-sensor can detect mechanical stimuli (e.g. pressure and shear strain) in a

decoupled way through cross measurement of electrical resistance and it can be used for skin-like tactile arrays.

keywords: {compressive testing;electrical resistivity;gold;plasticity;pressure sensors;shear strength;silicon compounds;tactile sensors;bidirectional substrate stretching;compression tests;elastic metallic thin films;electrical resistance;electrically conductive polymer composites;external mechanical stimuli;polymeric composites;shear strain testing;silicone-carbon black layer;skin-like tactile arrays;stretchable skin-like tactile sensor;Conductive films;Electric resistance;Gold;Mechanical sensors;Polymer films;Sensor phenomena and characterization;Strain measurement;Tactile sensors;Testing;Thin film sensors},

URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=5420644&isnumber=5420381>

D. Reuter *et al.*, "Hermetic thin film encapsulation of mechanical transducers for smart label applications," *TRANSDUCERS 2009 - 2009 International Solid-State Sensors, Actuators and Microsystems Conference*, Denver, CO, 2009, pp. 208-211.

doi: 10.1109/SENSOR.2009.5285526

Abstract: For realizing an active smart RFID label monitoring mechanical shock and inclination during transport processes, a capacitive inertial sensor has been developed. Hermetic sealing of the microstructures has been done by a wafer level thin film encapsulation technology based on CF-polymer as sacrificial layer material and a stress-optimized dielectric layer stack as capping material. Long term stability of the thin film encapsulation hermeticity in dependence of the material stack was tested by measuring the pressure inside the package using the pressure dependency of viscous damping between the electrode plates. For the used material stacks containing $\text{SiO}_x(\text{H}_y)$ or $\text{SiO}_x(\text{H}_y)/\text{SiN}_x(\text{H}_y)$ and sputtered aluminum a sufficient hermeticity with leak rates of $2\text{E-}10$ Pamiddotl/s and $6\text{E-}12$ Pamiddotl/s, respectively, could be achieved.

keywords: {aluminium;damping;encapsulation;hermetic seals;polymers;radiofrequency identification;silicon compounds;transducers;wafer level packaging;Al; $\text{SiO}_x(\text{H}_y)$; $\text{SiO}_x(\text{H}_y)$ - $\text{SiN}_x(\text{H}_y)$;capacitive inertial sensor;electrode plates;hermetic thin film encapsulation;leak rates;mechanical transducers;sacrificial layer material;smart RFID label monitoring mechanical shock;sputtered aluminum;stress-optimized dielectric layer stack;thin film encapsulation technology;transport processes;viscous damping;Active RFID tags;Dielectric materials;Dielectric thin films;Electric shock;Encapsulation;Monitoring;Radiofrequency identification;Sealing materials;Transducers;Transistors;2f-method;CF-polymer;hermeticity test;thin film encapsulation;wafer-level packaging},

URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=5285526&isnumber=5285368>

E. Saarimäki, M. Paajanen, A. M. Savijärvi and H. Minkkinen, "Novel heat durable electromechanical film processing: preparations for electromechanical and electret applications," *2005 12th International Symposium on Electrets*, 2005, pp. 220-223.

doi: 10.1109/ISE.2005.1612360

Abstract: New heat durable electromechanical films from cyclo-olefin polymers have been developed. Electromechanical film can act as a sensor and as an actuator. As a sensor dynamic force on the surface of the film generates electric charge and contrary as an actuator voltage is applied to the film and the electric field drives the film in an air gap producing acoustic sound (or vibration). Electromechanical operation and electret operation are possible for both application types. Electromechanical operation is based on the changes of the thickness of the film and electret operation is based on the movement of the film between the air gap. The application properties strongly depend on the preparations made to the film. The film preparations consist of stretching (void formation), gas diffusion expansion, electrostatic charging, fabrication of metal electrodes, making electrical connections and tensioning on a frame in electret operation. Cast film needs to be stretched to form voided structure to the film. Processing window for the stretching of the heat durable electromechanical films is very narrow compared to the PP-based films. Optimal voids in the film microstructure are flat and lens like. Gas diffusion expansion increases the film softness and thus the electromechanical sensitivity by further opening the cellular microstructure. Maximum film thickness is about $100\text{ }\mu\text{m}$ prior to the electrostatic charging. Charges applied to the film trap into the plastic-gas interfaces and form permanent space charges in the film. Partial discharges are being controlled by a constant current charging method. Metal electrodes are applied to the film and further connected by leads to operating systems and amplifiers. The sensitivity of the electromechanically operating sensors and actuators can be increased by stacking multiple layers of the film together. Applications based on a flat loudspeaker need to be tuned by tensioning the film on a support frame. Correct tensioning is essential in reducing distortion levels. In general lower tensioning leads to higher sound pressure levels due to the larger film movement but on the other hand higher tensioning reduces the distortion levels.

keywords: {diffusion;electric actuators;electromechanical effects;polymer films;sensors;space charge;voids (solid);acoustic sound;actuator;actuator voltage;air gap;cellular microstructure;cycloolefin polymers;distortion levels;electret operation;electric charge;electric field;electromechanical film processing;electromechanical sensitivity;electrostatic charging;film microstructure;film preparations;film surface;flat loudspeaker;gas diffusion expansion;metal electrodes;plastic-gas interfaces;sensor;sensor dynamic force;space charges;void formation;void structure;Acoustic sensors;Actuators;Electrets;Electrodes;Electromechanical sensors;Electrostatics;Force sensors;Microstructure;Plastic films;Polymer films},

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P. C. Beard, F. Perennes and T. N. Mills, "Transduction mechanisms of the Fabry-Perot polymer film sensing concept for wideband ultrasound detection," in *IEEE Transactions on Ultrasonics, Ferroelectrics, and Frequency Control*, vol. 46, no. 6, pp. 1575-1582, Nov. 1999.

doi: 10.1109/58.808883

Abstract: The transduction mechanisms of a wideband (30 MHz) contact ultrasound sensor based upon the use of a thin polymer film acting as a Fabry-Perot interferometer have been investigated. Polyethylene terephthalate (PET) sensing elements, illuminated by the free-space collimated output of a wavelength-tunable DBR laser diode, have been used to study the sensor transfer function, sensitivity, the effect of water absorption, and frequency response characteristics. Acoustic performance was evaluated by comparing the sensor output with that of a calibrated PVDF membrane hydrophone using laser-generated acoustic transients as a source of broadband ultrasound. An ultrasonic acoustic phase sensitivity of 0.1 rad/MPa , a linear operating range to 5 MPa , and a noise-equivalent-pressure of 20 kPa over a 25 MHz measurement bandwidth were obtained using a water-backed $50\text{ }\mu\text{m}$ PET sensing film. A model of frequency response that incorporates the effect of an adhesive layer between the sensor film and backing material has been developed and validated for different sensing film thicknesses, backing configurations, and adhesive layer thicknesses.

keywords: {Fabry-Perot interferometers;acousto-optical devices;polymer films;ultrasonic transducers;30 MHz;Fabry-Perot

interferometer;PET;acoustic phase sensitivity;adhesive layer;frequency response;linear range;measurement bandwidth;noise equivalent pressure;polyethylene terephthalate;polymer film;transduction;transfer function;water absorption;wideband contact ultrasound sensor;Acoustic sensors;Fabry-Perot interferometers;Frequency response;Polyethylene;Polymer films;Positron emission tomography;Sensor phenomena and characterization;Thin film sensors;Ultra wideband technology;Ultrasonic imaging},

URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=808883&isnumber=17519>

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doi: 10.1109/INEC.2010.5424483

Abstract: The following topics are dealt with: molecular self-assembly; solid surface; scanning tunnelling microscopy; nanoscale self-assembly; colloidal inorganic nanocrystals; in situ ultrahigh vacuum transmission electron microscope; microstructure; diluted magnetic semiconductors; nonlinear inorganic magnetoresistance; microwave-irradiated 2D semiconductor; nanostructured aggregates; organic luminogens; superconducting nanowires; 1D quantum waveguides; nano-bioceramics; macroscale carbon nanotube architecture; solar cells; gold nanocages; nanoelectronics; molecular beam epitaxial growth; multifunctional nanocomposite; functional boron nitride nanotubes; semiconductor nanowires; shaped nanomembranes; microscale electronic components; field electron emission devices; nanogenerators; nanopiezotronics; semiconductor lasers; molecular nanodevices; carbon nanotubes; ion nanofibres; ion-induced carbon-cobalt nanocomposite; metal-free carbon nanotubes; chemical vapour deposition; silicon nanowire arrays; localised carbon nanotube synthesis; flexible silicone substrate; high-efficiency thermoelectric devices; surface-enhanced Raman scattering; cathodoluminescence; micromanipulator; model-based infrared reflectometry; nanodiamond clusters; nano-data storage; neural network model; nanoscale lateral double-gate tunneling field effect transistor; electron mobility; graphene nanoribbon tunneling transistor; microporous carbons; graphene-based nanomolecule devices; indentation creep; multilayer epitaxial graphene; self-rectifying resistive memory; polymer films; flash memory; fully integrated circuit design Aihara chaotic neuron model; heat pipes-integrated circuit coolers; FinFET; terahertz surface-emitting distributed-feedback lasers; quantum dot nanocavity system; green fluorescent proteins; Raman mapping probing; zinc-doped superparamagnetic iron oxides; fluorescent DNA sensors; bioanalytes; DNA hybridisation; graphene layer synthesis; micromachined based dual-axes confocal microscope; pulsed laser ablation; polymer nanofibers; in vitro single cell study; photoluminescence; supercapacitors; holographic lithography; gas sensor; electron charge transfer; organic light emitting diodes; solid electrolyte; thermal stability; MOS capacitor; single-crystalline wurtzite aluminum nitride nanowires; pressure sensor; Portland cement; and oxidation.

keywords: {DNA;MOS capacitors;MOSFET;bioceramics;biosensors;carbon nanotubes;cellular biophysics;cements (building materials);charge exchange;creep;gas sensors;indentation;magnetoresistance;molecular beam epitaxial growth;molecular biophysics;nanobiotechnology;nanocomposites;nanowires;organic light emitting diodes;oxidation;polymer fibres;pressure sensors;reflectometry;scanning tunnelling microscopy;self-assembly;semiconductor lasers;semimagnetic semiconductors;1D quantum waveguides;DNA hybridisation;FinFET;MOS capacitor;Portland cement;Raman mapping probing;bioanalytes;carbon nanotubes;cathodoluminescence;chemical vapour deposition;colloidal inorganic nanocrystals;diluted magnetic semiconductors;electron charge transfer;electron mobility;field electron emission devices;flash memory;flexible silicone substrate;fluorescent DNA sensors;fully integrated circuit design Aihara chaotic neuron model;functional boron nitride nanotubes;gas sensor;gold nanocages;graphene layer synthesis;graphene nanoribbon tunneling transistor;graphene-based nanomolecule devices;green fluorescent proteins;heat pipes-integrated circuit coolers;high-efficiency thermoelectric devices;holographic lithography;in situ ultrahigh vacuum transmission electron microscope;in vitro single cell;indentation creep;ion nanofibres;ion-induced carbon-cobalt nanocomposite;localised carbon nanotube synthesis;macroscale carbon nanotube architecture;metal-free carbon nanotubes;micromachined based dual-axes confocal microscope;micromanipulator;microporous carbons;microscale electronic components;microstructure;microwave-irradiated 2D semiconductor;model-based infrared reflectometry; molecular beam epitaxial growth;molecular nanodevices;molecular self-assembly;multifunctional nanocomposite;multilayer epitaxial graphene;nanobioceramics;nanodata storage;nanodiamond clusters;nanoelectronics;nanogenerators;nanopiezotronics;nanoscale lateral double-gate tunneling field effect transistor;nanoscale self-assembly;nanostructured aggregates;neural network model;nonlinear magnetoresistance;organic light emitting diodes;organic luminogens;oxidation;photoluminescence;polymer films;polymer nanofibers;pressure sensor;pulsed laser ablation;quantum dot nanocavity system;scanning tunnelling microscopy;self-rectifying resistive memory;semicomacroscale carbon nanotube architecture;semiconductor nanowires;semiconductor lasers;shaped nanomembranes;silicon nanowire arrays;single-crystalline wurtzite aluminum nitride nanowires;solar cells;solid electrolyte;solid surface;supercapacitors;superconducting nanowires;surface-enhanced Raman scattering;terahertz surface-emitting distributed-feedback lasers;thermal stability;zinc-doped superparamagnetic iron oxides},

URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=5424483&isnumber=5424438>

J. Zhang and Y. Wang, "On the desien of intelligent insoles using PVDF film," *2016 Symposium on Piezoelectricity, Acoustic Waves, and Device Applications (SPAWDA)*, Xi'an, 2016, pp. 193-196.

doi: 10.1109/SPAWDA.2016.7829986

Abstract: In order to measure the plantar pressure in real time, this paper developed an intelligent insole device using PVDF piezoelectric thin film. Eight sensors were used in the intelligent insoles and they are designed by double-layer PVDF piezoelectric films. The signals of the sensors was sampled and processed by the signal system composed of the preamplifier circuit and the power frequency filter circuit. The output voltage of the single- and double-layer PVDF piezoelectric thin films were tested respectively. The results showed that under the same pressure, the double-layer structure can increase the output signal of the proposed sensors and therefore the precise of the measurement could be improved. The experiment also showed the data collected was stable and reliable.

keywords: {intelligent sensors;piezoelectric thin films;piezoelectric transducers;polymer films;power filters;preamplifiers;pressure sensors;signal sampling;thin film sensors;double-layer PVDF piezoelectric thin film;intelligent insole device;plantar pressure measurement;power frequency filter circuit;preamplifier circuit;sensor;signal sampling;single-layer PVDF piezoelectric thin film;Finite element analysis;Force;Intelligent sensors;Piezoelectric films;Piezoelectricity;Pressure measurement;PVDF piezoelectric thin film;Plantar pressure measurement;Signal conditioning circuit},

URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=7829986&isnumber=7829943>

X. Chen and D. Young, "Robust implantable blood pressure sensor packaging for long-term laboratory animals monitoring," *2016 IEEE SENSORS*, Orlando, FL, 2016, pp. 1-3.

doi: 10.1109/ICSSENS.2016.7808969

Abstract: A robust implantable blood pressure sensor packaging technique is demonstrated for long-term laboratory animals monitoring. The packaged sensors achieve a lifetime over 100 days in PBS solution at 37 °C, adequate for the proposed implantable application for life sciences research. The proposed packaging technique employs a multi-layer of Parylene and PDMS coating over a MEMS piezoresistive pressure sensor, thus effectively slowing down the moisture penetration and electrochemical etching of the metal traces on sensor surface or PCB surface under a bias condition. Further analysis of experimental results reveals a strong relationship between lifetime of packaged sensors and bias voltage level, suggesting a design trade-off between system sensitivity and reliability.

keywords: {biomedical transducers;blood pressure measurement;circuit reliability;coatings;electrochemical analysis;electronics packaging;etching;microfabrication;microsensors;polymer films;pressure sensors;printed circuits;MEMS piezoresistive pressure sensor;PBS solution;PCB surface;PDMS coating;electrochemical etching;life science research;long-term laboratory animal monitoring;moisture penetration;parylene coating;reliability;robust implantable blood pressure sensor packaging technique;surface;temperature 37 degC;Biomedical monitoring;Coatings;Micromechanical devices;Monitoring;Packaging;Pressure sensors;blood pressure sensor;implantable biomedical devices;long-term reliability;polymeric packaging},

URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=7808969&isnumber=7808393>

S. Hannah, D. Uttamchandani, H. Gleskova, S. Khan and R. Dahiya, "Response of P(VDF-TrFE) sensor to force and temperature," *2015 11th Conference on Ph.D. Research in Microelectronics and Electronics (PRIME)*, Glasgow, 2015, pp. 369-372.

doi: 10.1109/PRIME.2015.7251412

Abstract: Responses of a tactile sensor to force (0 to 9 N) and temperature (15 to 47°C) are investigated. The sensor is based on ferroelectric polyvinylidene fluoride - trifluoroethylene (P(VDF-TrFE)) copolymer. The 2.5- μ m-thick copolymer layer was sandwiched between aluminum and gold electrodes and the active sensing area was 25 mm². The response of the sensor was measured in a form of capacitance recorded at 2 kHz. The capacitance was measured in a steady-state condition, i.e. after the force and temperature have stabilized. We have found that the sensor's sensitivity to temperature is comparable to that of force, and even greatly exceeds the force sensitivity when dealing with forces larger than 3 N. This is because the response of the sensor to temperature is approximately linear, while the response to the applied force is logarithmic. Consequently, at the lower end of applied forces (< 0.5 N), the sensitivity is 7.5 pF/N while the temperature sensitivity is about 7 pF/°C within the whole temperature range.

keywords: {capacitive sensors;ferroelectric devices;polymer blends;polymer films;sensitivity;tactile sensors;temperature sensors;P(VDF-TrFE) sensor;capacitance measurement;ferroelectric polyvinylidene fluoride trifluoroethylene copolymer;force sensitivity;tactile sensor;temperature 15 degC to 47 degC;temperature sensitivity;Capacitance;Capacitance measurement;Force;Robot sensing systems;Sensitivity;Temperature measurement;Temperature sensors;Capacitance;P(VDF-TrFE);Pressure Response;Temperature Response},

URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=7251412&isnumber=7251078>

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doi: 10.1109/DTIP.2015.7161018

Abstract: Nowadays, flexible electronics is a challenging research area cause of the increase of electronics component request for "the internet of things", the food safety and the medical diagnostic applications. In our research, we work with an unusual substrate for microtechnologies such as paper, which is flexible, brittle, and biodegradable. Also, it can be folded, cut, perforated, crumpled, etc. This article focuses on monitoring porous Anodic Aluminum Oxide (AAO) layer on paper-based substrate for the detection of humidity. Porous AAO is a material with cylindrical pore geometry and high aspect ratio. Further, this material has many advantages, such as, easy fabrication, pore diameter's uniformity with high pore density (10¹¹/cm²) and its use like humidity sensors. In summary, the AAO process fabrication on paper substrate is challenging causes of his ease of implementation, cost-effective and the use of a highly economical, conformable and ecological substrate. In this study, an experimental setup had been developed to anodize an aluminum layer deposit on flexible substrate by using phosphoric acid. Various anodization parameters (voltage, current density, temperature and concentration) have been investigated to obtain an AAO layer with good electrical properties and high reliability on flexible substrate. An interdigital capacitance has been deposited on the best AAO layer produced to fabricate a moisture sensor. The different sensors produced had been characterized versus humidity concentration and frequency in a climatic chamber. Depending on the AAO morphology parameters, the average sensitivity can be tuned from 0.8 pF/RH% to 9 pF/RH%.

keywords: {aluminium compounds;anodisation;capacitance;flexible electronics;humidity sensors;paper;phosphors;porosity;thin film sensors;AAO morphology parameters;AAO process fabrication;Al₂O₃;Internet Of Things;aluminum layer deposit;anodization parameters;climatic chamber;cylindrical pore geometry;electronics component;flexible electronics;flexible substrate;food safety;high aspect ratio;interdigital capacitance;medical diagnostic applications;microtechnology;moisture sensor feasibility;paper-based substrate;phosphoric acid;porous AAO layer;Artificial intelligence;Biomedical monitoring;Moisture measurement;Monitoring;Polymers;Pressure measurement;Voltage measurement;aluminium oxide;humidity sensor;nanoporous AAO layer;paper-based substrate;thin film},

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doi: 10.1109/TNANO.2015.2422993

Abstract: Fully solution-processed elastic capacitive pressure sensors were fabricated by laminating two layers of silver nanowire (AgNW)/polydimethylsiloxane (PDMS) composite films. With AgNWs being partly embedded in the PDMS layer to create rough surface, the fabricated sensor device was able to achieve sensitivity three times of that using common metal film electrodes. The mechanism was investigated by comparing sensor devices using the electrodes with different surface roughness and characterizing the microstructure deformation at the surface region of the electrode under pressure using cross-sectional scanning electron microscopy. The devices also present fast response and relaxation (< 1 s). It is finally demonstrated that the placement and removal of a small weight leaf (30 mg, corresponding to a pressure of 2 Pa) can be reliably detected by the AgNW mesh electrode sensor devices.

keywords: {capacitive sensors;crystal microstructure;deformation;elasticity;laminates;liquid phase deposition;metallic thin

films;nanowires;polymer films;pressure sensors;scanning electron microscopy;silver;surface roughness;Ag;SEM;cross-sectional scanning electron microscopy;electrode surface region;fully solution-processed elastic capacitive pressure sensors;metal film electrodes;microstructure deformation;pressure 2 Pa;silver nanowire mesh electrode sensor devices;silver nanowire-polydimethylsiloxane composite films;small weight leaf placement;small weight leaf removal;surface roughness;Capacitive sensors;Electrodes;Films;Rough surfaces;Sensitivity;Surface roughness;Capacitive pressure sensor;capacitive pressure sensor;elastic electronics;silver nanowire;solution process},
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=7091948&isnumber=7151757>

T. Kuroki, K. Nakayama, D. Nakamura, T. Onji and M. Okubo, "Nonthermal Plasma Hybrid Process for Preparation of Organic Electroluminescence Fluoropolymer Film Devices," in *IEEE Transactions on Industry Applications*, vol. 51, no. 3, pp. 2497-2503, May-June 2015.

doi: 10.1109/TIA.2014.2365111

Abstract: In this paper, organic electroluminescence fluoropolymer film devices, i.e., organic light-emitting diodes (OLEDs) comprising polychlorotrifluoroethylene (PCTFE) films treated by an atmospheric-pressure nonthermal plasma (NTP) graft-polymerization process, are investigated. PCTFE films can provide a long lifetime for OLEDs because of their excellent gas barrier properties; however, they are difficult to laminate, owing to low adhesiveness. The surfaces of PCTFE films are treated by an atmospheric-pressure NTP-graft-polymerization process to improve their adhesiveness, and then, indium tin oxide and a luminous layer are deposited on the treated PCTFE films. As a result, OLEDs comprising PCTFE films are successfully demonstrated.

keywords: {electroluminescence;indium compounds;organic light emitting diodes;polymer films;polymerisation;thin film devices;tin compounds;ITO;OLED;PCTFE film surfaces;atmospheric-pressure nonthermal plasma graft-polymerization process;gas barrier properties;indium tin oxide;luminous layer;nonthermal plasma hybrid process;organic electroluminescence fluoropolymer film devices;organic light-emitting diodes;polychlorotrifluoroethylene films;pressure 1 atm;Films;Luminescence;Organic light emitting diodes;Plasmas;Polymers;Surface morphology;Surface treatment;Fluoropolymer films;Graft polymerization;Nonthermal plasma;Organic light-emitting diodes;Surface treatment;graft polymerization;nonthermal plasma (NTP);organic light-emitting diodes (OLEDs);surface treatment},
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=6936887&isnumber=7109193>

S. Khan, S. Tinku, L. Lorenzelli and R. S. Dahiya, "Flexible Tactile Sensors Using Screen-Printed P(VDF-TrFE) and MWCNT/PDMS Composites," in *IEEE Sensors Journal*, vol. 15, no. 6, pp. 3146-3155, June 2015.

doi: 10.1109/JSEN.2014.2368989

Abstract: This paper presents and compares two different types of screen-printed flexible and conformable pressure sensors arrays. In both variants, the flexible pressure sensors are in the form of segmental arrays of parallel plate structure-sandwiching the piezoelectric polymer polyvinylidene fluoride trifluoroethylene [P(VDF-TrFE)] between two printed metal layers of silver (Ag) in one case and the piezoresistive [multiwall carbon nanotube (MWCNT) mixed with poly(dimethylsiloxane (PDMS))] layer in the other. Each sensor module consists of 4×4 sensors array with 1-mm $\times$ 1-mm sensitive area of each sensor. The screen-printed piezoelectric sensors array exploits the change in polarization level of P(VDF-TrFE) to detect dynamic tactile parameter such as contact force. Similarly, the piezoresistive sensors array exploits the change in resistance of the bulk printed layer of MWCNT/PDMS composite. The two variants are compared on the basis of fabrication by printing on plastic substrate, ease of processing and handling of the materials, compatibility of the dissimilar materials in multilayers structure, adhesion, and finally according to the response to the normal compressive forces. The foldable pressure sensors arrays are completely realized using screen-printing technology and are targeted toward realizing low-cost electronic skin.

keywords: {filled polymers;flexible electronics;multi-wall carbon nanotubes;nanofabrication;nanosensors;piezoelectric devices;piezoresistive devices;polymer films;pressure sensors;sensor arrays;tactile sensors;thin film sensors;C;MWCNT-PDMS composites;conformable pressure sensor array;dynamic tactile parameter detection;electronic skin;foldable pressure sensor array;multilayer structure;multiwall carbon nanotube;normal compressive force;piezoelectric polymer polyvinylidene fluoride trifluoroethylene;piezoresistive sensor;plastic substrate;poly(dimethylsiloxane) layer;printed metal layer;screen printed P(VDF-TrFE) composites;screen printed flexible tactile sensor array;screen printed piezoelectric sensor array;segmental parallel plate structure array;size 1 mm;Electrodes;Piezoresistance;Printing;Sensor arrays;Substrates;Flexible Electronics;Piezoelectric Sensors;Piezoresistive Sensors;Screen Printing;Screen printing;Tactile Sensors;flexible electronics;piezoelectric sensors;piezoresistive sensors;tactile sensors},
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=6967772&isnumber=7086408>

S. Khan, W. Dang, L. Lorenzelli and R. Dahiya, "Printing of high concentration nanocomposites (MWNTs/PDMS) using 3D-printed shadow masks," *2015 XVIII AISEM Annual Conference*, Trento, 2015, pp. 1-4.

doi: 10.1109/AISEM.2015.7066786

Abstract: This paper presents an attractive and feasible approach for developing large area flexible pressure sensors by using high concentration nanocomposites of multiwall carbon nanotubes (MWNTs) mixed in poly (dimethyl-siloxane) (PDMS). A shadow mask is prepared by using 3D printer and employed for the patterned deposition of nanocomposites on 25 μ m thick flexible polyethylene terephthalate (PET) substrate. Sensors are developed in the form of 4 modules in single step, each containing arrays of 4×4 interconnected sensors. A parallel plate capacitive structure is followed, whereby, MWNTs/PDMS nanocomposites layers are packed in two printed silver plates of 1×1 mm² area each. An encapsulation layer of another pet substrate is adhered on top of these printed sensors, containing top electrodes and force concentrated structures on each side respectively. Three different (by wt. %) nanocomposite solutions are prepared which are finally printed by using a shadow mask developed by 3D printer. An investigative study has been carried out in this research in which an easy and cost-effective technique for patterned deposition of nonhomogeneous nanocomposites with high percolation ratios is developed. Here the change in resistance values upon application of normal compressive forces is investigated to monitor the applied stress. The modular expansion of this type of sensor could be advanced for possible application as a tactile sensor in an electronic skin for robots and general purpose applications.

keywords: {flexible structures;masks;multi-wall carbon nanotubes;nanocomposites;nanofabrication;nanosensors;polymer films;pressure sensors;sensor arrays;silver;thin film sensors;three-dimensional printing;3D printed shadow mask;3D printer;MWNT-PDMS nanocomposites layer;PET substrate;encapsulation layer;flexible polyethylene terephthalate;flexible pressure sensor;force concentrated

structure;interconnected sensor array;modular expansion;multiwall carbon nanotube;nonhomogeneous nanocomposites;parallel plate capacitive structure;patterned deposition;poly (dimethyl-siloxane);printed sensor;printed silver plate;Nanocomposites;Plastics;Printing;Resistance;Sensor arrays;Substrates;Composites;Flexible sensors;MWNT;PDMS;Piezoresistance;Screen Printing;Tactile Sensing},

URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=7066786&isnumber=7066758>

Y. Zhuang *et al.*, "Novel spray coating process with polymer material applied in CIS wafer-level-packaging," *2014 IEEE 16th Electronics Packaging Technology Conference (EPTC)*, Singapore, 2014, pp. 688-692.

doi: 10.1109/EPTC.2014.7028410

Abstract: This paper studies a creative spray coating process applied to the forming of sidewall insulation of through silicon via (TSV) in CMOS image sensor (CIS) packaging. In this paper, through controlling the nitrogen gas pressure, rate of polymer solution flow and plate temperature, we present a low-temperature-first and high-temperature-last spray coating method. Using this novel spray coating process, one kind of phenolic aldehyde polymer is deposited on the sidewall of through silicon via with the diameter of 65 μ m and depth of 120 μ m. To promote the performance of TSV sidewall insulation and electrical interconnection characteristic, the thickness of polymer on the sidewall was aimed to not less than 2 μ m. The temperature of spray coating process was adjusted to control the viscosity of polymer to achieve the insulation layer thickness target value. Finally, we fabricate the adequate polymer insulation layers in the certain aspect ratio (2:1) TSV structure successfully.

keywords: {CMOS image sensors;insulating materials;polymer films;spray coating techniques;three-dimensional integrated circuits;viscosity;wafer level packaging;CIS wafer-level-packaging;CMOS image sensor packaging;TSV sidewall insulation;electrical interconnection characteristic;insulation layer thickness;phenolic aldehyde polymer;polymer insulation layers;polymer material;polymer viscosity;spray coating process;through silicon via;Coatings;Insulation;Packaging;Polymers;Silicon;Through-silicon vias;Viscosity},

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doi: 10.1109/TNANO.2014.2362536

Abstract: By using ultrahigh aspect ratio (>2000:1) silver nanowires (AgNWs) and ethanol-diluted poly (3,4-ethylenedioxythiophene):poly(styrenesulfonate) (PEDOT:PSS) as the overcoating layer, we achieved flexible AgNW-polymer composite transparent electrodes of high conductivity and optical transmittance using facile solution processes at room temperature without annealing. The electrodes were applied in fabricating flexible capacitive pressure sensors and organic photovoltaic (OPV) devices. The pressure sensor with the composite electrodes presents three times higher sensitivity than that using ITO electrodes. A flexible 4 $\times$ 4 sensor array was also fabricated, which well proved the capability of the electrodes for spatially electronic signal collection and transmission. The fabricated flexible OPV device has a power conversion efficiency of 1.83%, which proves the potential of the electrodes for multilayer integration in optoelectronic device applications.

keywords: {capacitive sensors;conducting polymers;electrical conductivity;electrodes;flexible electronics;infrared spectra;nanocomposites;nanowires;polymer solutions;pressure sensors;sensor arrays;silver;solar cells;ultraviolet spectra;visible spectra;Ag;annealing-free solution process;efficiency 1.83 percent;ethanol-diluted PEDOT:PSS;flexible 4 $\times$ 4 sensor array;flexible capacitive pressure sensors;flexible device applications;optical transmittance;optoelectronic device applications;organic photovoltaic devices;poly (3,4-ethylenedioxythiophene):poly(styrenesulfonate);power conversion efficiency;silver nanowire-polymer composite transparent electrodes;temperature 293 K to 298 K;Annealing;Capacitive sensors;Conductivity;Electrodes;Films;Indium tin oxide;Capacitive pressure sensors;capacitive pressure sensors;flexible electronics;organic photovoltaic devices;silver nanowires;transparent electrodes},

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A. Eshkeiti *et al.*, "Screen printed flexible capacitive pressure sensor," *IEEE SENSORS 2014 Proceedings*, Valencia, 2014, pp. 1192-1195.

doi: 10.1109/ICSENS.2014.6985222

Abstract: A novel flexible fully printed capacitive based pressure sensor was designed and fabricated using screen printing technique. Silver (Ag) ink and polydimethylsiloxane (PDMS) were printed on a flexible polyethylene terephthalate (PET) substrate as metallization and dielectric layers, respectively. The capacitive response of the sensor demonstrated a percentage change of 1 % and 3.6 % for compressive forces of 0.2 MPa and 2.4 MPa, respectively when compared to the base capacitance. The response of the pressure sensor is analyzed and presented in this paper.

keywords: {capacitive sensors;dielectric thin films;flexible electronics;polymer films;pressure sensors;semiconductor device metallisation;silver;thick film sensors;Ag;PDMS;PET;compressive forces;dielectric layers;flexible polyethylene terephthalate;metallization;polydimethylsiloxane;pressure 0.2 MPa to 2.4 MPa;screen printed flexible capacitive pressure sensor;Capacitance;Dielectrics;Electrodes;Fabrication;Ink;Printing;Substrates},

URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=6985222&isnumber=6984913>

R. Gando *et al.*, "Evaluation of gas permeability for micro-scale thin polymer film with encapsulated MEMS damped oscillator," *IEEE SENSORS 2014 Proceedings*, Valencia, 2014, pp. 970-973.

doi: 10.1109/ICSENS.2014.6985164

Abstract: We present a practical method to evaluate gas permeability for thin polymer films using an encapsulated micro-electro-mechanical-system (MEMS) oscillator. Previously, we have developed a hermetic thin-film dome structure for RF-MEMS tunable capacitor, using conventional back-end-of-the-line (BEOL) processes. The dome is made of multiple layers including a polymer film, whose gas permeability is an important factor with respect to productivity and reliability. So far, it had been difficult to evaluate the gas permeability for such small and thin polymer films with sub-millimeter diameter and micron-scale thickness. In this evaluation method, the pressure dependence of air-damping oscillation is used to measure the permeability. As a demonstration, we carried out a permeability measurement of a 0.5-mm-diameter dome sealed with a thin (1 μ m) polymer film. The resulting permeability coefficient is found to be 1×10^{-16} mol/m/Pa/s, at room temperature.

keywords: {damping;encapsulation;microfabrication;microsensors;permeability;polymer films;pressure measurement;radiofrequency oscillators;thin film capacitors;thin film sensors;RF-MEMS tunable capacitor;air damping oscillation;backend of the line process;encapsulated MEMS damped oscillator;gas permeability evaluation;hermetic thin film dome structure;microelectromechanical system;microscale thin polymer film;size 0.5 mm;size 1 μ m;Damping;Micromechanical devices;Oscillators;Permeability;Polymer films;Q-factor;MEMS;Quality factor;damping oscillation;gas permeability;polymer film},

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X. Mi and F. Nakazawa, "A multipoint thin film polymer pressure/force sensor to visualize traditional medicine palpations," *IEEE SENSORS 2014 Proceedings*, Valencia, 2014, pp. 843-846.

doi: 10.1109/ICSENS.2014.6985131

Abstract: This paper describes a novel multipoint thin film polymer pressure/force sensor enabling detection of pressure/force pulse wave. The sensor features a high sensibility of 11mv/mmHg along with an extremely thin thickness of 100 μ m and a high flexibility to adapt to the radial artery portion. The sensor uses charged cellular polymer as sensing layer, which contains 25 separated sensing dots to avoid signal interaction among these sensing points. The sensor attaches to a person's wrist to detect the radial artery vibration, while a physician palpates the artery vibration with his fingertips on it. The sensor is thin and flexible enough to let the artery vibration transmit through it without spoiling the physician's tactile feeling. That makes it possible to correlate the measured pressure/force pulse wave and the physician's pulse diagnosis in real time. That is useful for objectification and quantification of pulse palpation in traditional medicine.

keywords: {biomedical equipment;blood vessels;force measurement;force sensors;patient diagnosis;polymer films;pressure measurement;pressure sensors;thin film sensors;charged cellular polymer;multipoint thin film polymer pressure-force sensor;physician palpates;physician pulse diagnosis;pressure-force pulse wave measurement;pulse palpation;radial artery portion;radial artery vibration;sensing layer;traditional medicine palpations;Arteries;Force sensors;Medical diagnostic imaging;Medical services;Polymers;Vibrations;analog information;cellular polymer;flexibility;multipoint;palpation;pressure/force sensor;pulse diagnosis;radial artery;tactile;thin film;traditional medicine},

URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=6985131&isnumber=6984913>

T. H. N. Dinh, P. Y. Joubert, E. Martincic and E. Dufour-Gergam, "Flexible 3-axes capacitive pressure sensor array for medical applications," *IEEE SENSORS 2014 Proceedings*, Valencia, 2014, pp. 855-858.

doi: 10.1109/ICSENS.2014.6985134

Abstract: Wearable pressure sensors arrays are required for various monitoring purposes in medicine. To meet with the wanted specifications, capacitive sensors arrays realized on highly flexible substrates have been proven to be good candidates to let non-invasive as well as accurate stress measurements to be carried out. Since single-axis pressure measurements may be found incomplete in some applications, capacitive arrays featuring 3-axes pressure sensing capabilities are considered in this study. A sensor array prototype featuring 25 element 3-axes micro-sensors are designed. They are realized on a flexible substrate (Kapton) using PDMS as a deformable dielectric material, by means of an original transfer of film technique. The principle of operation of such sensors is based on the capacitance change of capacitive sensors with the deformation of the dielectric layer separating the sensor electrodes, under an applied stress. Finite element computations are carried to foresee and optimize the sensors sensitivity to stress. Electromechanical tests are carried out on the realized sensors for validation purposes.

keywords: {biomedical electronics;capacitive sensors;dielectric materials;finite element analysis;microsensors;pressure sensors;PDMS deformable dielectric material;capacitance change;capacitive arrays;capacitive sensors arrays;dielectric layer deformation;finite element computation;flexible Kapton substrate;flexible capacitive pressure sensor array;highly flexible substrates;medical applications;microsensors;three-axis capacitive pressure sensor array;wearable pressure sensor

arrays;Arrays;Capacitance;Electrodes;Films;Robot sensing systems;Stress;3-axes pressure sensor array;capacitive sensor;experimental characterization;finite element mechanical computations;flexible sensor;microfabrication process;polymer-based sensor;sensor design},

URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=6985134&isnumber=6984913>