TECHNISCHE UNIVERSITÄT
IN DER KULTURHAUPTSTADT EUROPAS
CHEMNITZ

Faculty of Electrical Engineering and Information Technology
Institute for Microsystems and Semiconductor Technology
Professorship Measurement and Sensor Technology

Publications Report

Editor: Prof. Dr.-Ing. Olfa Kanoun
Stand: 31.12.2021

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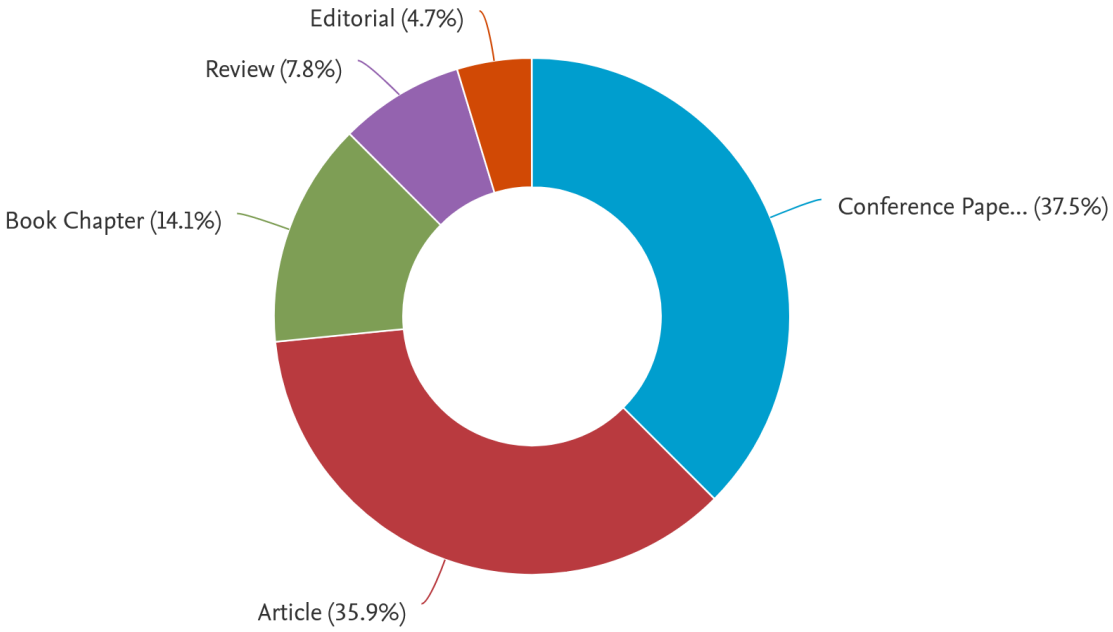
1 Publications Overview

1.1 Documents by Type



1.2 Main Keywords and Topics

- Energy Harvesting – Autonomous Wireless Sensors– Piezo Electric Converters – Inductive Power Transmission – Electromagnetic Energy Converter – Energy Management
- Compressive Sensing – Data Aggregation – Low Power Communication– Internet Of Things
- Nanocomposite and Filament Sensors based on: Multiwalled Carbon Nanotubes – Graphene – Polymers – Ceramics
- Pressure Sensors – Strain Sensors – Temperature Sensors – Humidity Sensors – Pressure Distribution Sensors – Temperature Self-Compensated Sensors – High-Temperature Sensors – RFID Sensors
- Functional Integration of Sensors in Structures – Materials and Textiles
- Nanogenerators – Piezoelectric Nanogenerator – Structural Health Monitoring
- Impedance Spectroscopy – Inductance Spectroscopy – Inductive Sensors – Bioimpedance Spectroscopy – Battery Diagnosis – Cable Identification – Cable Diagnosis – Electric Impedance Tomography (EIT) –Frequency Domain Analysis
- Electrochemical Sensors – Biosensors – Gas Sensors – Volatile Organic Compounds (VOC) – Cyclic Voltammetry – Electrochemical Impedance Spectroscopy – Electrodes
- Wearable Sensors – Gesture Recognition – Hand-gesture Recognition – American Sign Language – Surface Electromyography – Gait Analysis
- Machine Learning – Classification (of Information) – Learning Algorithms – Feature Extraction
- Industrial Applications – Industry 4.0 – Automotive applications – Environmental Applications – Medical Applications – Materials

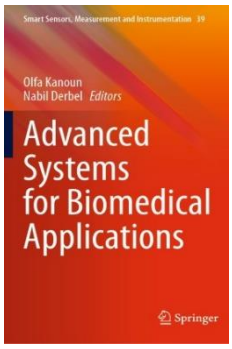
1.3 International Co-Authorship

Tunisia -Jordan- France – Italy – Brazil- Russian Federation -Saudi Arabia-Finland – Serbia – Spain - Sweden

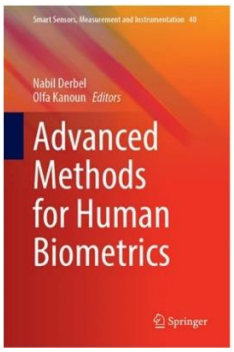
2 Books

Olfa Kanoun, Nabil Derbel
Advanced Sensors for Biomedical Applications
Springer
ISBN: 978-3-030-71224-2

Olfa Kanoun, Nabil Derbel
Advanced Systems for Biomedical Applications
Springer
ISBN: 978-3-030-71220-4



Nabil Derbel, Olfa Kanoun
Advanced Methods for Human Biometrics
Springer
ISBN: 978-3-030-81981-1



O. Kanoun, Chr. Viehweger
Frontiers of Science and Technology
De Gruyter
ISBN 978-3-11-058407-3

3 Journal Covers

Sensors
Volume 21, Issue 12 (June-2 2021)
– 311 articles

https://www.mdpi.com/1424-8220/21/12

Electronics
Volume 10, Issue 23 (December-1 2021)
– 163 articles

https://www.mdpi.com/2079-9292/10/23

4 Impedance Spectroscopy and Measuring Systems

IOPscience Journals Books Publishing Support Login

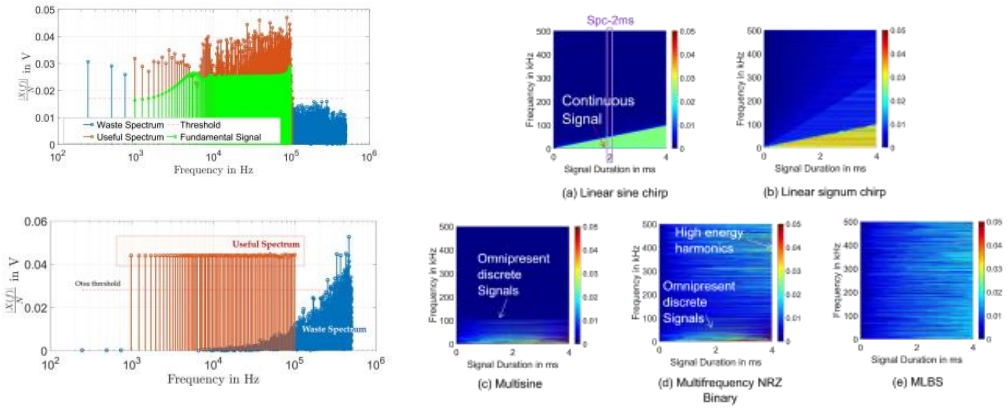
Measurement Science and Technology Volume 32, Number 8

MST MEASUREMENT AND SENSOR TECHNOLOGY

Critical implementation issues of excitation signals for embedded wearable bioimpedance spectroscopy systems with limited resources

A Y Kallel[1], D Bouchaala[2] and O Kanoun[3,1]

Meas. Sci. Technol. 32 (2021) 084011 (14pp)
https://doi.org/10.1088/1361-6501/abf78e



Abstract

Wideband excitation signals are essential in bioimpedance spectroscopy for measurements in a time ensuring a quasi-stable measurement condition. In particular, for wearable biomedical systems, due to limited system resources, several aspects regarding measurement time, crest factor, slew rate requirements, frequency distribution, amplitude spectrum, and energy efficiency need to be thoroughly investigated. In this paper, we present an investigation of excitation signals, which includes not only the theoretical aspects but also aspects of real implementation on microcontroller-based systems. At a fixed number of samples and sampling rate, we investigate the implementability of signal frequencies and the resulting spectral efficiency. We focus on sources of signal distortion due to timer and amplitude deviations. The results show that for 4096 samples and a sampling frequency of 1 MHz, wideband signals are 2.76 times faster than a stepped frequency sweep. The multisine signal provides a better energy efficiency and has a lower slew rate requirement on hardware (around 0.3 V μs^{-1}), but has a relatively high crest factor, even after optimization. An exemplary investigation of the distortion of the time/frequency and amplitudes following implementation on a standard industrial advanced RISC machines microcontroller has shown that a sampling rate compensation is required to overcome timer inaccuracies. Furthermore, non-return-to-zero binary signals are more sensitive to distortion due to hardware-related issues and have a lower signal-to-distortion-and-noise (SINAD) ratio than 24 dB, which is lower than the multisine signal, having a SINAD of 31 dB.

Keywords: bioimpedance spectroscopy, excitation signal, spectral energy efficiency, crest factor, embedded systems, real implementation, timer

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Measurement Science and Technology

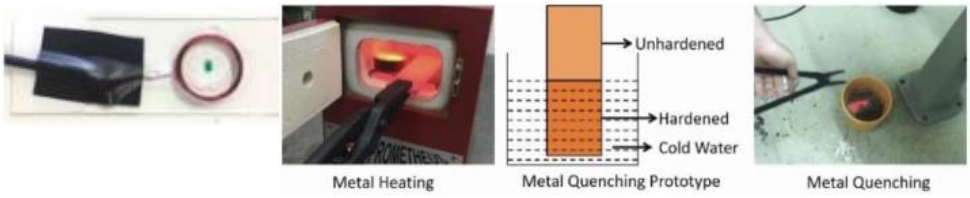
MST MEASUREMENT AND SENSOR TECHNOLOGY

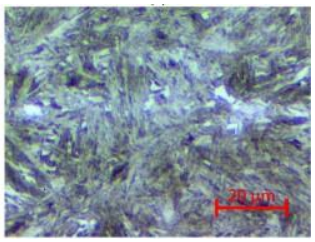
PAPER

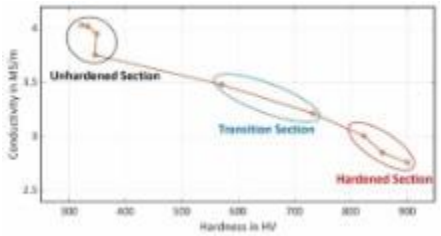
Effect of hardening on electrical and magnetic properties of C-75 steel and characterization with multi-frequency inductance spectroscopy

Rohan Munjal[1], Frank Wendler[1], André Leonhardt[2], Peter Birnbaum[2], Verena Kräusel[2] and Olfa Kanoun[1]

Rohan Munjal *et al* 2021 *Meas. Sci. Technol.* **32** 024009







Abstract

Non-destructive monitoring of metal hardness is important for process monitoring and product quality assessment. In this paper, a partially hardened metal sample is assessed in regards to physical effects using multi-frequency inductance spectroscopy. For this purpose, the influence of change of conductivity, permeability and stress on the inductance spectra are analyzed. To extract the numerical values of permeability, the measured inductance spectra are compared to the analytical inductance model. Statistical analysis with principal component analysis is conducted to fuse the spectral data into a single representative value. The results show the possibility to obtain information from different layers of the partially hardened sample, thus indicating a strong relationship between the measured inductance and restraint hardening.

sensors MDPI

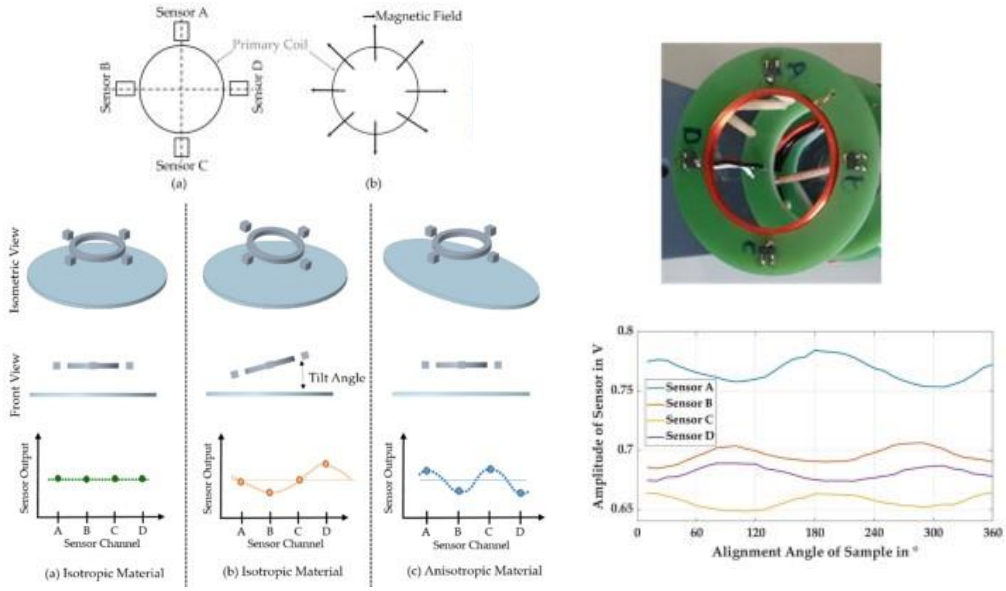
MST MEASUREMENT AND SENSOR TECHNOLOGY

Communication

Eddy Current Sensor System for Tilting Independent In-Process Measurement of Magnetic Anisotropy

Frank Wendler [1], Rohan Munjal [1], Muhammad Waqas [1], Robert Laue [2], Sebastian Härtel [2], Birgit Awiszus [2] and Olfa Kanoun [1,*]

Sensors 2021, 21(8), 2652;
https://doi.org/10.3390/s21082652



Abstract

Modern production equipment is based on the results of quality control as well as process parameters. The magnetic anisotropy of materials is closely connected to internal mechanical stress by the Villari effect, and also to hardening effects due to plastic deformations, and could therefore provide an interesting basis for process control. Nevertheless, the analysis of anisotropic properties is extremely sensitive to sensor and workpiece misalignments, such as tilting. In this work, a novel eddy current sensor system is introduced, performing a non-contact measurement of the magnetic anisotropy of a workpiece and realizing a separation and correction of tilting effects. The measurement principle is demonstrated with the example of two samples with different magnetic anisotropy values induced by cold forming. Both samples are analyzed under different tilt angles between the sensor axis and the surface of the workpiece. In this work, digital signal processing is demonstrated on the acquired raw data in order to differentiate the effects of tilt and of anisotropy, with the use of preliminary results as an example of two prepared samples. View Full-Text

Keywords: eddy current sensors; magnetic sensor; magnetic anisotropy; tilting correction; inductance spectroscopy; impedance spectroscopy

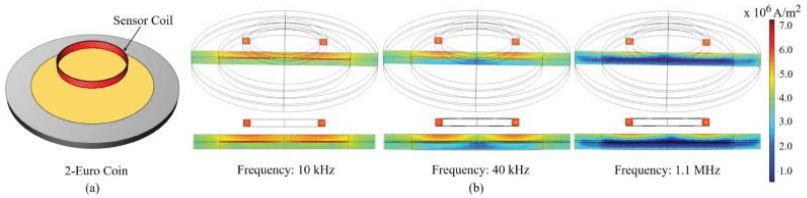
IEEE TRANSACTIONS ON
INSTRUMENTATION
AND MEASUREMENT

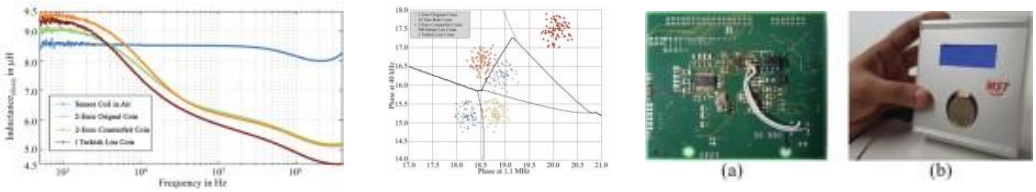
MST
MEASUREMENT AND
SENSOR TECHNOLOGY

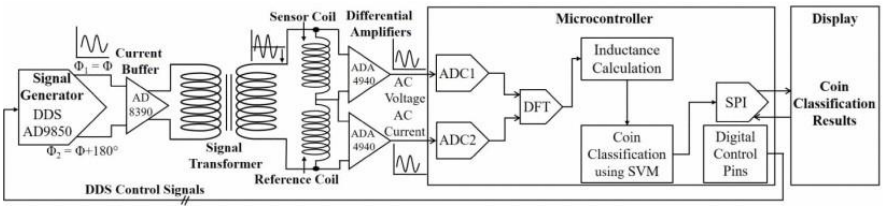
Multifrequency Inductive Sensor System for Classification of Bimetallic Coins

Rohan Munjal, Farhan Ahmad Sajjad, Frank Wendler, and Olfa Kanoun

IEEE Transactions on Instrumentation and Measurement, vol. 70, pp. 1-9, 2021, Art no. 2500709, doi: 10.1109/TIM.2020.3011489





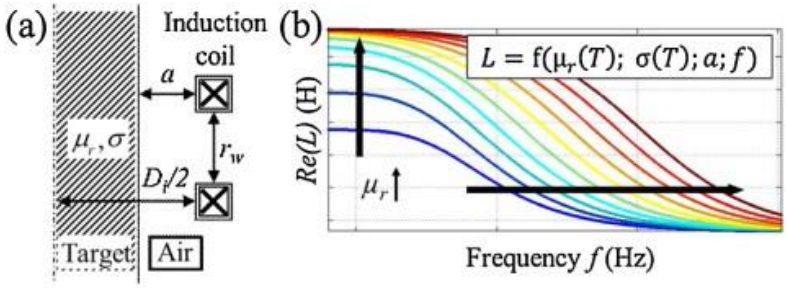


Abstract:
The reliable classification of coin sets from different countries and counterfeit coins is an essential means of securing cash circulation. Especially bimetallic coins, such as 2-Euro coins, are often subjected to counterfeit by mixing them with coins of other countries or by imitations. In this article, a real-time embedded sensor system is proposed, based on inductance spectroscopy to characterize and identify bimetallic coins having similar geometric properties and looking similar at a first view. The system is based on inductance spectroscopy varying the penetration depth of the magnetic field in the bimetallic structure of the coin, which generally contains buried layers of other metals. The experimental evaluation shows that the bimetallic coins from different countries can be identified and classified by the use of the support vector machine, a machine learning algorithm. Experimental results showed that the system reached a classification accuracy up to 100% within a response rate of 36.62 ms per five bimetallic coins.

CIRP Journal of Manufacturing Science and Technology
Volume 33, May 2021, Pages 240-246

Induction coil as sensor for contactless, continuous in-process determination of steel microstructure by means of Magnetic Induction Spectroscopy (MIS)

André Leonhardt [a], Frank Wendler [b], Rafael Wertheim [(1)c, d], Verena Kräusel [(3)a, d], Olfa Kanoun [b]



D_i – Inner diameter of coil winding
r_w – Coil winding distance
a – Coupling distance

Abstract

In hot forming and machining process chains heat treatment of steels is controlled by temperature and time. The process parameters significantly influence the material microstructure, which is important for the final component properties. The dependence between the predominant microstructure and the magnetic properties can be determined by means of Magnetic Induction Spectroscopy (MIS). In this paper, we propose to use the induction coil as an in-process sensor element to implement MIS in induction heating processes with subsequent cooling of steel sheets. This novel approach enables contactless, continuous in-process measurement of complex inductance and allows a non-destructive determination of steel microstructure. The novel measurement method can differentiate discrete microstructural states and determine phase transformation points during continuous heating and cooling, by analysing the inductance curve. The realized combination of sensor and actuator features enables both process monitoring and closed-loop control of production processes with integrated heat treatment.

tm – Technisches Messen 2021; aop

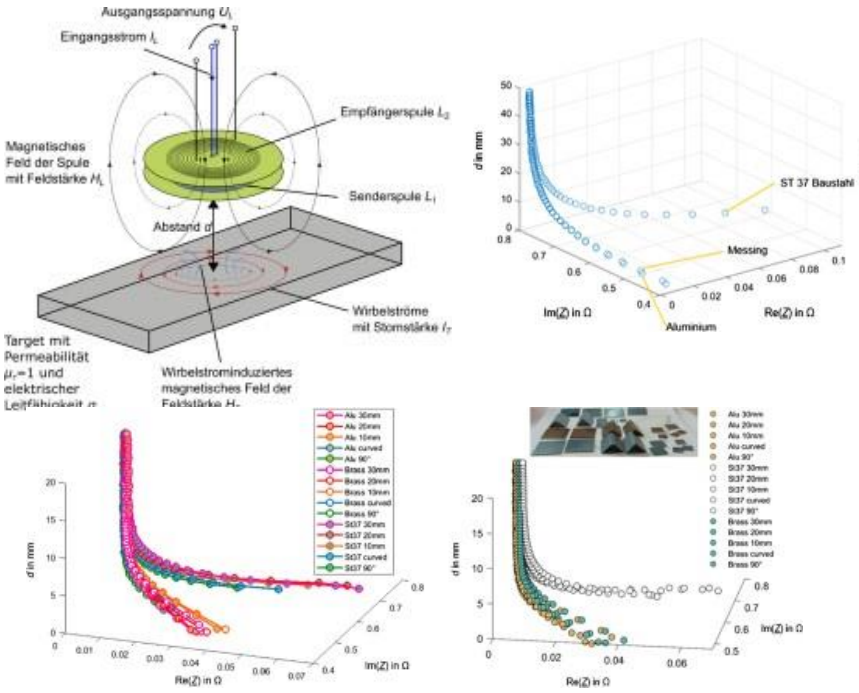
DE GRUYTER OLDENBOURG

Robert Schulze*, Michael Bauer-Wesely, Frank Wendler und Olfa Kanoun

Kombinierte Abstands- und Materialerkennung mit induktiven Näherungssensoren

Combined distance and material detection with inductive proximity sensors

tm - Technisches Messen , vol. 88, no. 9, 2021, pp. 531-543.
https://doi.org/10.1515/teme -2020-0099



Zusammenfassung

Die kontinuierliche Weiterentwicklung induktiver Näherungsschalter erweitert zunehmend deren Anwendungsbereiche. Gleichzeitig erlauben der stetige Fortschritt der Mikroelektronik und die höhere Integration von Rechen- und Speicherelementen in Mikrokontrollern komplexere Datenverarbeitung in kompakten Sensorsystemen. In diesem Beitrag wird ein neues Messverfahren vorgeschlagen, das zusätzlich zur eigentlichen Funktion der Präsenzerkennung bzw. Abstandsmessung die Unterscheidung verschiedener Target-Materialien ermöglicht. Das Prinzip dieses Verfahrens wird zunächst vorgestellt und mithilfe eines automatisierten Messaufbaus demonstriert. Im Anschluss werden der Einfluss des Materials, der Einbauumgebung und unterschiedlicher Targets dargestellt und diskutiert. Hierfür werden verschieden geformte Targets und verschiedene Targetgrößen der bereits vorgestellten Materialien eingesetzt. Es werden Potentiale dieses Verfahrens in Bezug auf die Unterscheidbarkeit der Targetmaterialien, der Einbauumgebung und Targetform diskutiert und die weitere Übertragbarkeit des Verfahrens bewertet. Abschließend wird die industrielle Verwertbarkeit beurteilt.

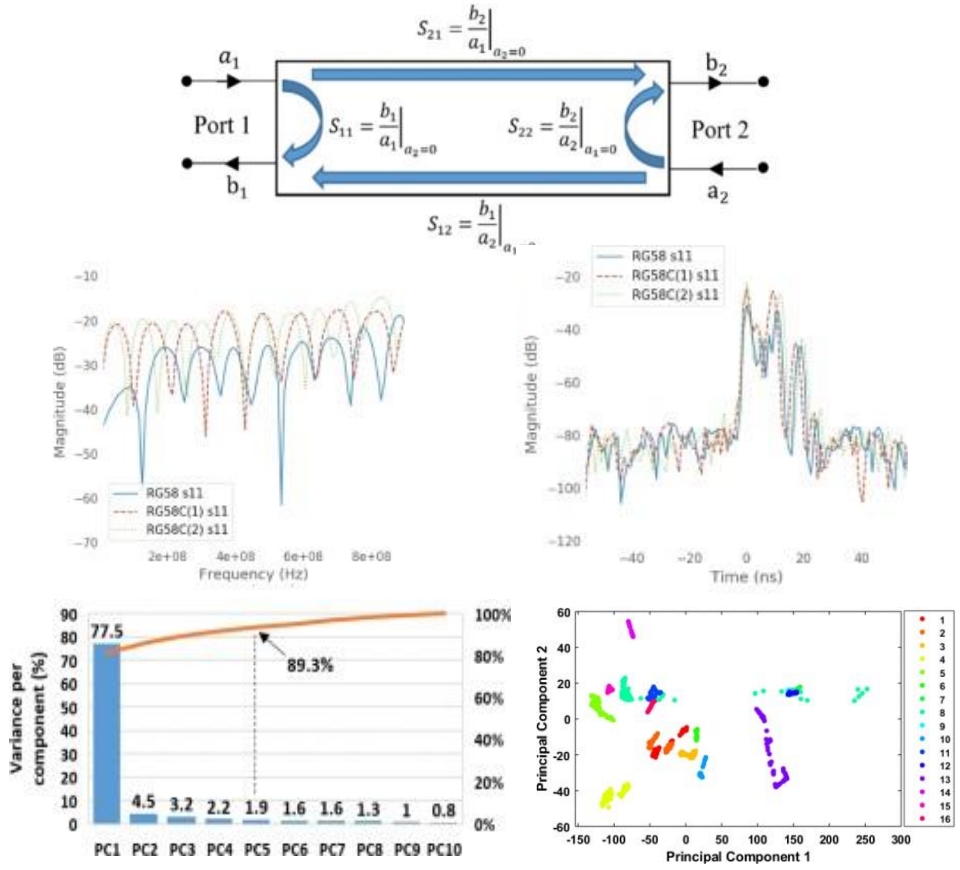
IEEE Sensors Letters VOL. 5, NO. 7, JULY 2021

MST MEASUREMENT AND SENSOR TECHNOLOGY

Identification of Communication Cables Based on Scattering Parameters and a Support Vector Machine Algorithm

Oumaima Bader[1,2], Dhia Haddad[1,2], Ahmed Yahia Kallel[1], Tarek Hassine[3], Najoua Essoukri Ben Amara[2], and Olfa Kanoun[1]

IEEE Sensors Letters, vol. 5, no. 7, pp. 1-4, July 2021, Art no. 6001504,
DOI: 10.1109/LSENS.2021.3087539



Abstract—The identification of cables is becoming increasingly important due to the higher complexity of technical equipment and installations. In this letter, we propose a method for identifying coaxial communication cables based on the scattering parameters at 101 frequencies for 16 coaxial communication cables with a characteristic impedance of 50 Ω and various lengths, dimensions, and connector types. For classification, we consider the ready cable, with its specific length and type as a whole, as a unique class. The support vector machine (SVM) algorithm is used because of its ability to process high-dimensional spaces with linearly inseparable data. The achieved classification results when applying the principal component analysis on a database, including the input port reflection's magnitude values, show a testing accuracy of 100% with only five principal components. The method is suitable for realization as an embedded system.

Index Terms—Sensor applications, artificial intelligence, cable identification, cable impedance, communication cables, scattering parameters, supervised learning, support vector machine (SVM).

applied sciences

MDPI

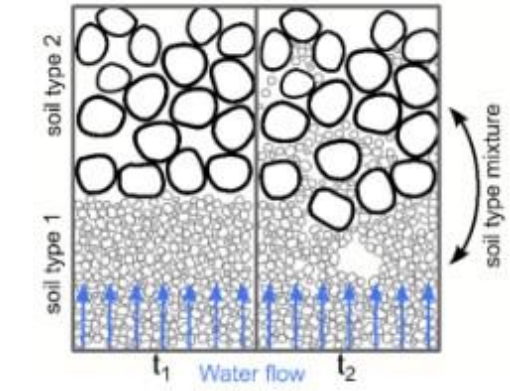
MST MEASUREMENT AND SENSOR TECHNOLOGY

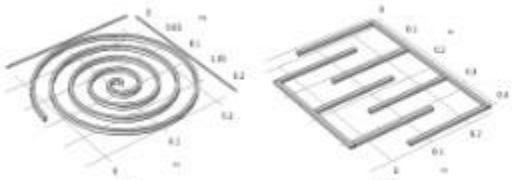
Open Access Article

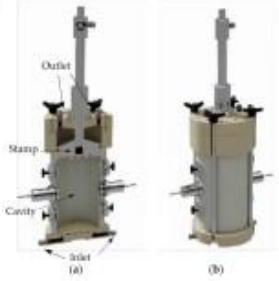
Detection of Density Changes in Soils with Impedance Spectroscopy

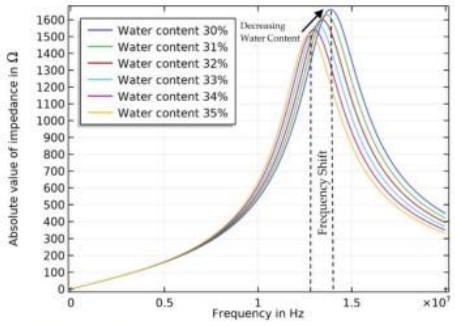
by Christoph Clemens [1,*], Mario Radschun [1], Annette Jobst [1], Jörg Himmel [1] and Olfa Kanoun [2]

Appl. Sci. **2021**, *11*(4), 1568; https://doi.org/10.3390/app11041568









Abstract

Measurement of soil parameters, such as moisture, density and density change, can provide important information for evaluating the stability of earthwork structures and for structural health monitoring. To ensure the stability of flood protection dikes, erosion at the contact zones of different soil zones must be avoided. In this work we propose the use of impedance spectroscopy to measure changes in density and volume caused by contact erosion. Erosion leads generally to a volume decrease in the contact zones between soils with different grain sizes and, consequently, to cavities in the dike structure. For this purpose, a proctor mould was developed for emulating contact erosion and the realisation of impedance measurements. Experimental investigations show a correlation between volume change of the soils in the proctor mould and impedance value. For a volume change of soil in the range of approximately 1.5% to 5.3%, an impedance change arises in the range of 17.2% to 29.8%. With several investigations we proof, that it is possible to detect material transport by impedance spectroscopy. View Full-Text

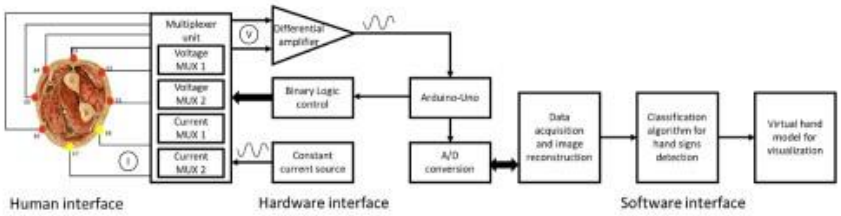
Keywords: Impedance spectroscopy; vector-network-analyser; geotechnics; structural health monitoring; density change measurement; modelling

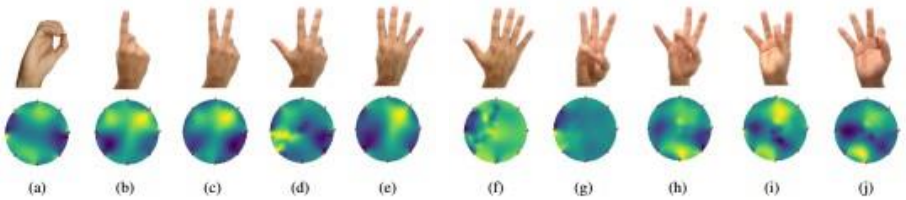
IEEE SENSORS JOURNAL
IEEE Sensors Council
MST MEASUREMENT AND SENSOR TECHNOLOGY

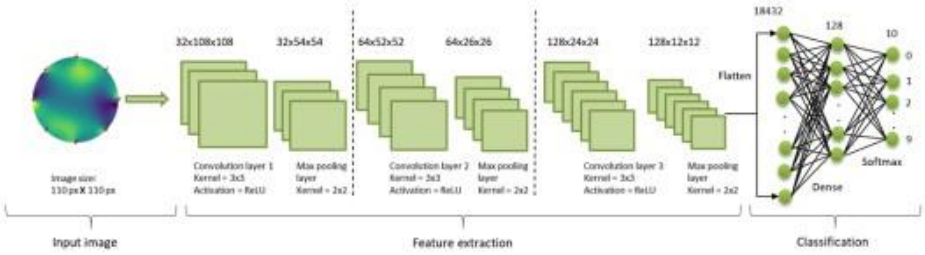
Hand Sign Recognition System based on EIT Imaging and Robust CNN Classification

Bilel Ben Atitallah, *Member, IEEE*, Zheng Hu, Dhouha Bouchaala, Mohammed Abrar Hussain, Amir Ismail, Nabil Derbel, *Senior Member, IEEE*, and Olfa Kanoun, *Senior Member, IEEE*

IEEE Sensors Journal, doi: 10.1109/JSEN.2021.3130982







Abstract:
Hand sign recognition is gaining importance in human-human and in human-machine communication and interaction. Electrical Impedance Tomography (EIT) is thereby very interesting as it provides information on impedance changes in depth of the section of the arm, which infers muscle contractions. This paper introduces an EIT imaging system for hand sign recognition and monitoring having a low complexity and including an electronic interface with 8 electrodes placed on the forearm, a Gauss-Newton image reconstruction algorithm, a robust CNN based hand sign classification and a virtual hand model for visualization. A database has been collected for EIT measurements in pole mode taken by eight subjects performing the American sign language numbers from 0 to 9. The overall imaging system is validated using a water tank system, where conductive objects can be changed in properties and positions. The correspondence between the reconstructed images and the expected muscle behavior for the hand signs is investigated. A robust Convolutional Neural Network (CNN) classification algorithm was implemented and optimized by implementing an Adam optimizer and conducting a dedicated study to avoid overfitting. The results obtained by CNN are compared to the results by a Support Vector Machine (SVM), and a Softmax classifier. They show a classification accuracy of 95.94%, 75.61%, and 62.9% respectively. In term of subject dependency, the system using the CNN model shows a higher performance, as the accuracy decreases only by 0.72% while increasing the number of subjects from one to eight. Finally, for visualization, a 3D virtual hand model is designed and controlled based on detected hand signs.

IEEE SENSORS JOURNAL
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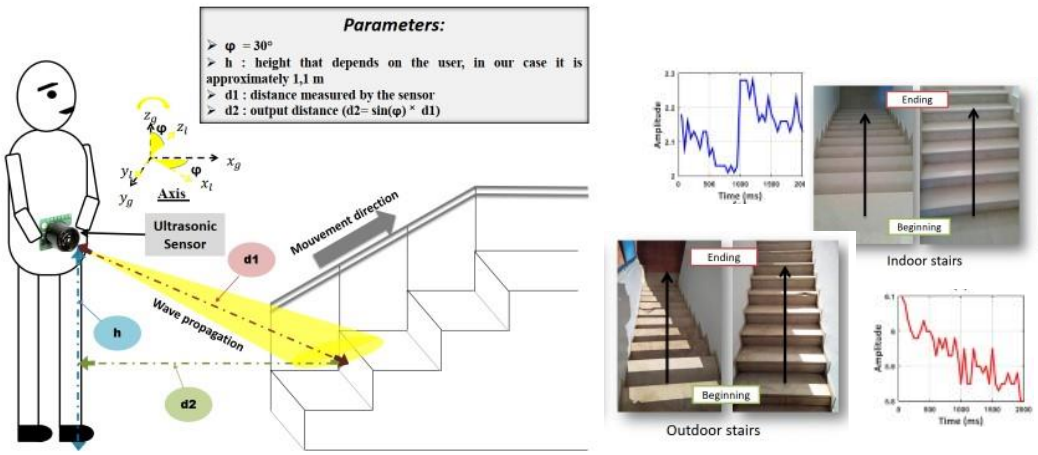
MST MEASUREMENT AND SENSOR TECHNOLOGY

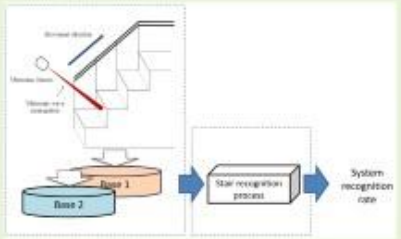
Electronic embedded system for stair recognition based on possibilistic modeling of ultrasonic signal

M. Medhioub, I. Khanfir Kallel, S. Ammar Bouhamed, N. Derbel, *Senior Member, IEEE*, B. Solaiman, O. Kanoun, *Senior Member, IEEE*

IEEE Sensors Journal, vol. 21, no. 5, pp. 5787-5797, 1 March1, 2021,
doi: 10.1109/JSEN.2020.3035834.



***Abstract*—Safe navigation is a common challenge for humans, as well as for mobile robots. Embedded devices offering autonomous navigation are increasingly required. To fulfill this requirement, various navigation systems have been proposed. Most of them are designed to avoid collisions with objects from the scene. However, some other obstacles, such as stairs, are posing a real danger and unfortunately, they did not attract sufficient attention to get a reliable and practical solution. In this paper, we propose a new electronic system for staircase detection and recognition based on ultrasonic (US) signals. The designed system can be used for indoor and outdoor applications to detect stairs and to recognize their nature (ascending or descending). The challenge here is to process in real-time a small sample size of an ultrasonic signal. Various features in time and frequency are used to characterize as much as possible the ultrasonic signals acquired for each of the two classes of stairs. Possibilistic models of the selected features are built for each class. The paper presents the electronic architecture, as well as the ultrasonic signal processing schemes for the stair recognition task. A rate of up to 93% is reached for staircase recognition using the proposed system.**



***Index Terms*—Electronic embedded system ultrasonic sensor ultrasonic signal processing features selection possibilistic modeling stair case recognition.**

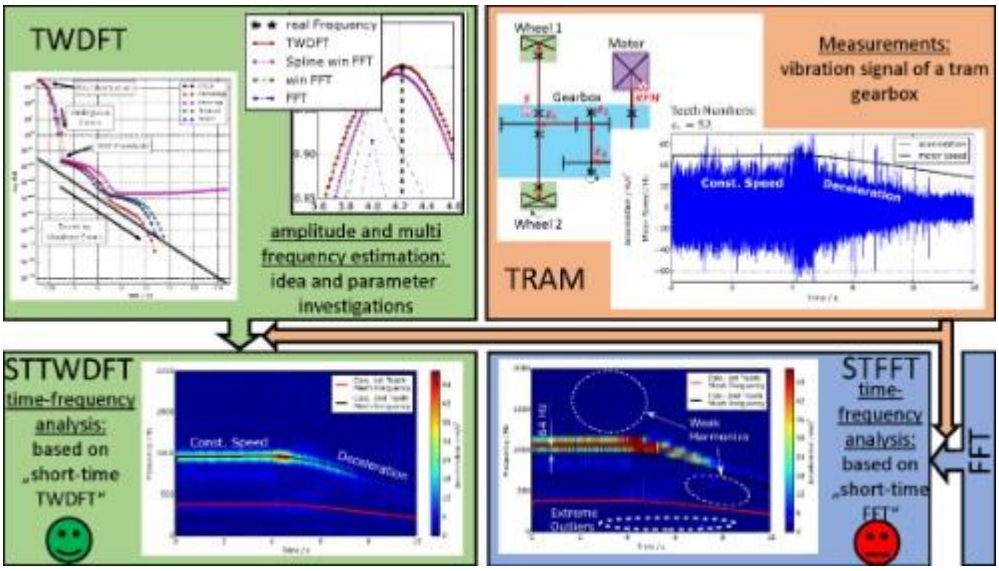
JVE JOURNAL OF VIBROENGINEERING

MST MEASUREMENT AND SENSOR TECHNOLOGY

Amplitude and frequency estimator for aperiodic multi-frequency noisy vibration signals of a tram gearbox

Maik Wolf[1], Mathias Rudolph[2], Olfa Kanoun[3]

Journal of Vibroengineering, Vol. 23Jssue 7, 2021, p. 1492- 1507.
https://doi.org/10.21595/jve.2021.21855



Abstract. Sinusoidal parameter estimation for determining frequency position and amplitude is challenging for noisy short vibration signals, e.g. from machines or human vibrations. In this paper, we propose the "Trimmed Window Discrete Fourier Transform" (TWDFT) estimator, which uses for every frequency a one-point discrete Fourier transform (DFT) to determine the corresponding spectral amplitude. To avoid leakage effects, it cuts the time interval so that it corresponds to an integer number of period durations. To evaluate the estimator performance, we compare it with relevant estimators such as the Cramer-Rao lower bound (CRLB) and the spectral spline interpolation applied on a noisy mono-frequent test signal with a fractional frequency. For the estimated parameters, the mean squared errors (MSE) are calculated and compared as a function of the signal-to-noise ratio (SNR). The advantages of the TWDFT estimator can be seen over the whole SNR range. The TWDFT estimates are better than the fast Fourier transform (FFT) starting at a SNR of –6 dB. At a SNR of 30 dB, the estimator meets the real value of the frequency and reaches similar results as the CRLB. The application of the TWDFT estimator as a short-time analysis on a vibration signal of a tram gearbox shows a significantly more differentiated time-frequency analysis compared to a short-time Fourier transform (STFT).

Keywords: Frequency and amplitude estimation, aperiodic and multi-frequency signals, DFT, noise, Cramer-Rao lower bound, signal segmentation, tram gearbox, structure-borne noise, predictive maintenance.

Concurrency and Computation
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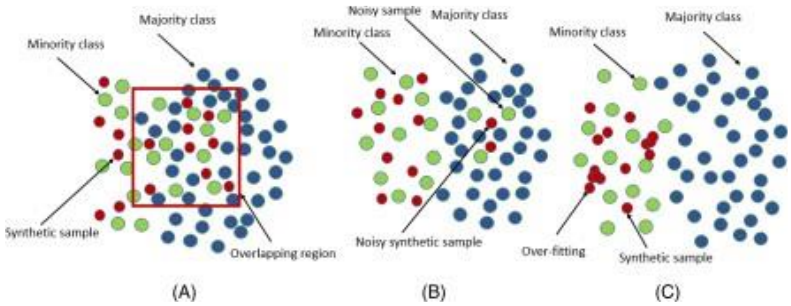
RESEARCH ARTICLE | Full Access

High performance oversampling technique considering intra-class and inter-class distances

Nesrine Keskes, Sameh Fakhfakh, Olfa Kanoun, Nabil Derbel

https://doi.org/10.1002/cpe.6753



Summary

Oversampling methods are among the most widely used methods to solve imbalanced data analysis due to their simplicity and flexibility. Multi-class imbalanced problems involve critical issues related to synthetic samples and corresponding consequences on the classification results. The over-fitting phenomenon, the overlapping regions between classes, and the existence of noisy original samples may lead to a non-optimal data distribution, which inadequately affects the classifier performance. To avoid these limitations, we propose a novel oversampling technique based on the intra-distance-matrix (IntraDM) and the inter-distance-matrix (InterDM). The new samples are created to decrease over-fitting, decline the generation of outliers, and minimize the overlap areas. Applying the proposed method on 14 available datasets shows that it outperforms common oversampling techniques in terms of classification evaluation metrics.

KEYWORDS

imbalanced data, inter-condition, inter-distance, intra-distance, oversampling

5 Wireless Energy-Aware Sensors

electronics MDPI

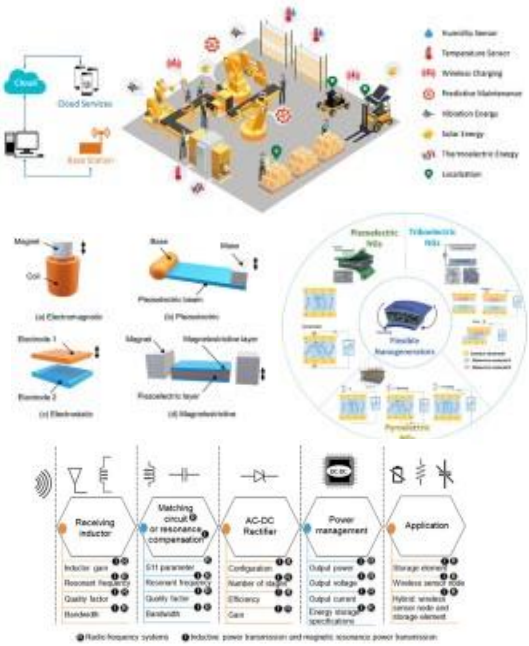
MST MEASUREMENT AND SENSOR TECHNOLOGY

Open Access Review

Prospects of Wireless Energy-Aware Sensors for Smart Factories in the Industry 4.0 Era

by Olfa Kanoun *, Sabrine Khriji, Slim Naifar, Sonia Bradai, Ghada Bouattour, Ayda Bouhamed, Dhouha El Houssaini and Christian Viehweger

Electronics **2021**, *10*(23), 2929; https://doi.org/10.3390/electronics10232929



Abstract

Advanced sensors are becoming essential for modern factories, as they contribute by gathering comprehensive data about machines, processes, and human-machine interaction. They play an important role in improving manufacturing performance, in-factory logistics, predictive maintenance, supply chains, and digitalization in general. Wireless sensors and wireless sensor networks (WSNs) provide, in this context, significant advantages as they are flexible and easily deployable. They have reduced installation and maintenance costs and contributed by reducing cables and preinstalled infrastructure, leading to improved reliability. WSNs can be retrofitted in machines to provide direct information from inside the processes. Recent developments have revealed exciting possibilities to enhance energy harvesting (EH) and wireless energy transmission, enabling a reliable use of wireless sensors in smart factories. This review provides an overview of the potential of energy aware WSNs for industrial applications and shows relevant techniques for realizing a sustainable energy supply based on energy harvesting and energy transfer. The focus is on high-performance converter solutions and improvement of frequency, bandwidth, hybridization of the converters, and the newest trends towards flexible converters. We report on possibilities to reduce the energy consumption in wireless communication on the node level and on the network level, enabling boosting network efficiency and operability. Based on the existing technologies, energy aware WSNs can nowadays be realized for many applications in smart factories. It can be expected that they will play a great role in the future as an enabler for digitalization in this decisive economic sector. View Full-Text

Keywords: energy harvesting; vibration converters; energy saving; wireless power transfer; wireless communication; WSN

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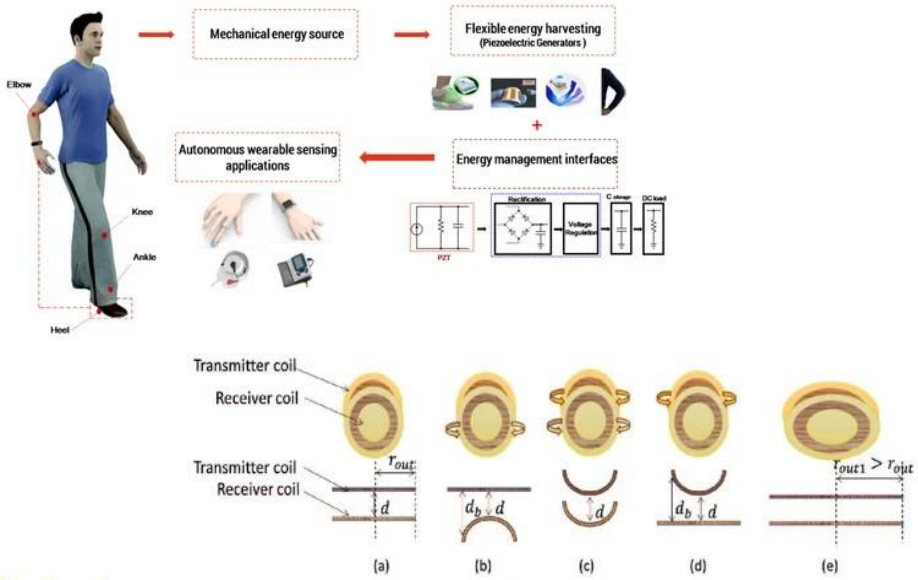
MST MEASUREMENT AND SENSOR TECHNOLOGY

Open Access Review

Edge Devices for Internet of Medical Things: Technologies, Techniques, and Implementation

by Imed Ben Dhaou [1,2,3,*], Mousameh Ebrahimi [4], Meriam Ben Ammar [5], Ghada Bouattour [5] and Olfa Kanoun [5]

Electronics 2021, 10(17), 2104; https://doi.org/10.3390/electronics10172104



Abstract

The health sector is currently experiencing a significant paradigm shift. The growing number of elderly people in several countries along with the need to reduce the healthcare cost result in a big need for intelligent devices that can monitor and diagnose the well-being of individuals in their daily life and provide necessary alarms. In this context, wearable computing technologies are gaining importance as edge devices for the Internet of Medical Things. Their enabling technologies are mainly related to biological sensors, computation in low-power processors, and communication technologies. Recently, energy harvesting techniques and circuits have been proposed to extend the operating time of wearable devices and to improve usability aspects. This survey paper aims at providing an overview of technologies, techniques, and algorithms for wearable devices in the context of the Internet of Medical Things. It also surveys the various transformation techniques used to implement those algorithms using fog computing and IoT devices. View Full-Text

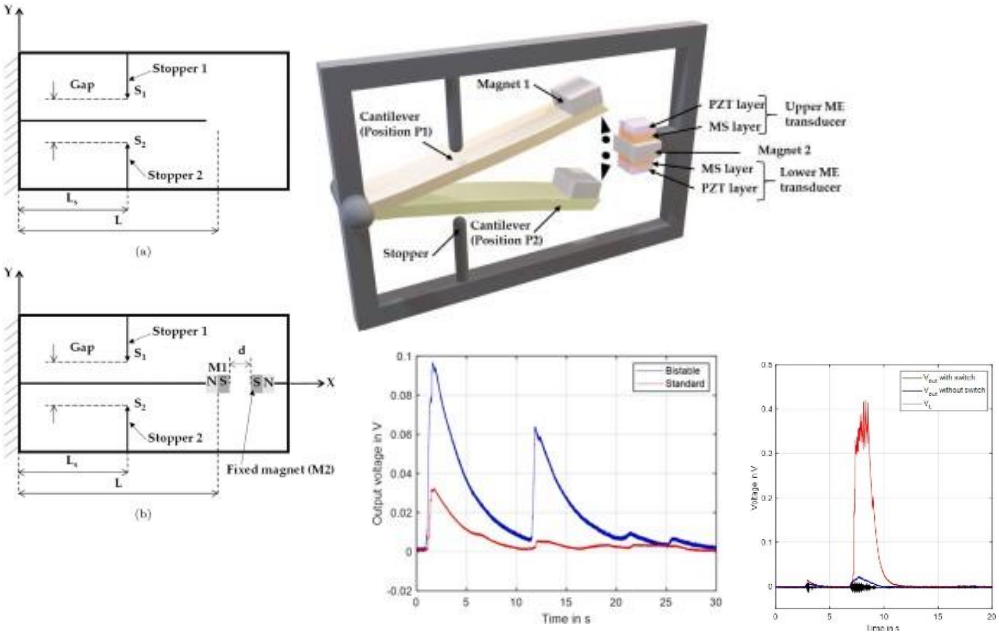
Keywords: e-health; fog computing; energy harvesting; IoMT

Measurement
Volume 177, June 2021, 109307

An electromagnetic/magnetoelectric transducer based on nonlinear RMSHI circuit for energy harvesting and sensing

Sonia Bradai [a,*], Slim Naifar [a], Carlo Trigona [b], Salvatore Baglio [b], Olfa Kanoun [a]

Measurement, Volume 177, 2021, 109307,
https://doi.org/10.1016/j.measurement.2021.109307



ABSTRACT

Random mechanical switching harvester on inductor (RMSHI) circuits for voltage rectification present a promising approach to enable the use of low output voltages from electromagnetic transducers under weak vibration conditions. In this paper, an electromagnetic transducer, which is suitable for noisy environments and realizes a high energy income even under a boradband excitation is presented. The proof-of concept system is realized and functionally tested. Further, in order to characterize the behavior of the mechanical bistable switch relative to the applied vibration, a passive solution is proposed. It consists of the use of two magnetoelectric (ME) transducers added to the bistable structure. The proposed solution is investigated with different random vibration profiles and vibration frequency bandwidths. Results have shown that the performance of the electromagnetic transducer due to the bistable RMSHI solution and in presence of random kinetic sources, is significantly improved. Further, the mechanical power is passively evaluated relative to the output of the two ME transducers based on the commutation of the cantilever between the two ME transducers. The achieved results have a high potential for the development of an integrated energy harvesting solution from weak and random kinetic sources with sensing capabilities.

The Journal of Supercomputing
An International Journal of High-Performance Computer Design, Analysis, and Use

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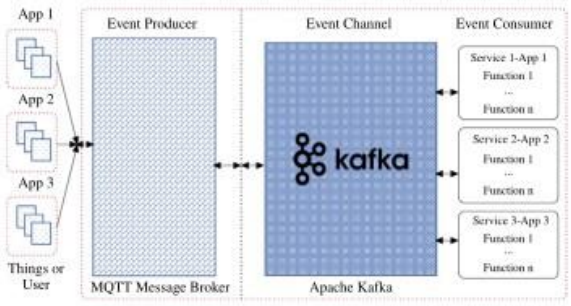
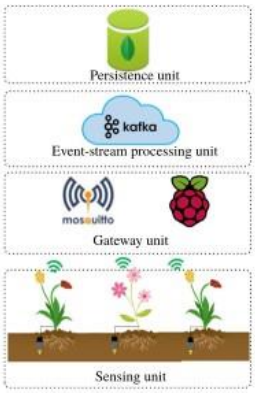
MEASUREMENT AND SENSOR TECHNOLOGY

Design and implementation of a cloud-based event-driven architecture for real-time data processing in wireless sensor networks

Sabrine Khriji, Yahia Benbelgacem, Rym Chéour, Dhouha El Houssaini & Olfa Kanoun

The Journal of Supercomputing (2021)
https://doi.org/10.1007/s11227-021-03955-6





Abstract
The growth of the Internet of Things (IoTs) and the number of connected devices is driven by emerging applications and business models. One common aim is to provide systems able to synchronize these devices, handle the big amount of daily generated data and meet business demands. This paper proposes a cost-effective cloud-based architecture using an event-driven backbone to process many applications' data in real-time, called REDA. It supports the Amazon Web Service (AWS) IoT core, and it opens the door as a free software-based implementation. Measured data from several wireless sensor nodes are transmitted to the cloud running application through the lightweight publisher/subscriber messaging transport protocol, MQTT. The real-time stream processing platform, Apache Kafka, is used as a message broker to receive data from the producer and forward it to the correspondent consumer. Micro-services design patterns, as an event consumer, are implemented with Java spring and managed with Apache Maven to avoid the monolithic applications' problem. The Apache Kafka cluster co-located with Zookeeper is deployed over three availability zones and optimized for high throughput and low latency. To guarantee no message loss and to simulate the system performances, different load tests are carried out. The proposed architecture is reliable in stress cases and can handle records goes to 8000 messages in a second with low latency in a cheap hosted and configured architecture.

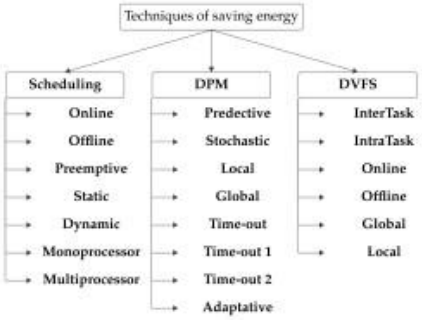
Keywords Cloud computing · Event-driven · Micro-services · Kafka · Wireless sensor network · Internet of things · Amazon web service IoT

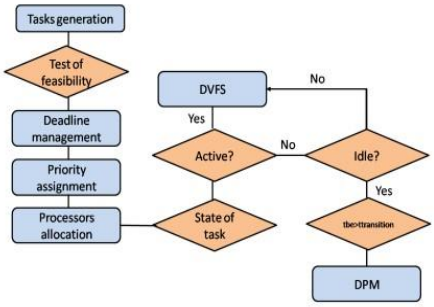
sensors MDPI MST MEASUREMENT AND SENSOR TECHNOLOGY

Towards Hybrid Energy-Efficient Power Management in Wireless Sensor Networks

by Rym Chéour [1,*], Mohamed Wassim Jmal [1], Sabrine Khriji [2], Dhouha El Houssaini [2], Carlo Trigona [3], Mohamed Abid [1] and Olfa Kanoun [2]

Sensors **2022**, *22*(1), 301; https://doi.org/10.3390/s22010301





Abstract

Wireless Sensor Networks (WSNs) are prone to highly constrained resources, as a result ensuring the proper functioning of the network is a requirement. Therefore, an effective WSN management system has to be integrated for the network efficiency. Our objective is to model, design, and propose a homogeneous WSN hybrid architecture. This work features a dedicated power utilization optimization strategy specifically for WSNs application. It is entitled Hybrid Energy-Efficient Power manager Scheduling (HEEPS). The pillars of this strategy are based on the one hand on time-out Dynamic Power Management (DPM) Intertask and on the other hand on Dynamic Voltage and Frequency Scaling (DVFS). All tasks are scheduled under Global Earliest Deadline First (GEDF) with new scheduling tests to overcome the Dhall effect. To minimize the energy consumption, the HEEPS predicts, defines and models the behavior adapted to each sensor node, as well as the associated energy management mechanism. HEEPS's performance evaluation and analysis are performed using the STORM simulator. A comparison to the results obtained with the various state of the art approaches is presented. Results show that the power manager proposed effectively schedules tasks to use dynamically the available energy estimated gain up to 50%.

Keywords: **wireless sensor networks (WSN); power management; energy saving; microcontrollers; hardware optimization; energy harvesting; scheduling; DPM; DVFS; simulation**

Measurement: Sensors
Volume 18, December 2021, 100347

A review on intelligent IoT systems design methodologies

Nissaf Fredj, Yessine Hadj Kacem, Sabrine Khriji, Olfa Kanoun, Mohamed Abid

Measurement: Sensors 18 (2021) 100347

ARTICLE INFO

Keywords
IoT
Adaptation
Interaction
AI
MDE
UML/- MARTE

ABSTRACT

The design of distributed real-time systems including In- ternet of Things (IoT) systems is complex due to open-ended architectures requirements. An emergent solution to deal with this complexity and to manage system constraints is the integration of adaptation strategies in distributed devices behavior. The developement of such systems denotes a signifi-cant challenge on providing autonomous and intelligent ability to verify distributed devices behaviors and constraints such as battery storage of sensors. Existing AI-based approaches for dynamic IoT systems proposed solutions relative to the target system for resolving specific problems without consid-ering interoperability and reusability. Using MDE approach and UML/MARTE profile for high-level abstraction becomes a promising solution to ease the design of intelligent IoT systems. This paper recalls and classifies the existing AI and MDE-based works for the design of dynamic distributed systems especialy IoT applications. We concentrate on a set of criteria to highlight the shortages of existing approaches on the design of distributed devices interaction, adaptation and system constraints. Finally, we introduce our future directions to cope with the limits of existing solutions while taking into account the observed criteria.

6 Flexible and Nanocomposite Sensors

sensors MDPI

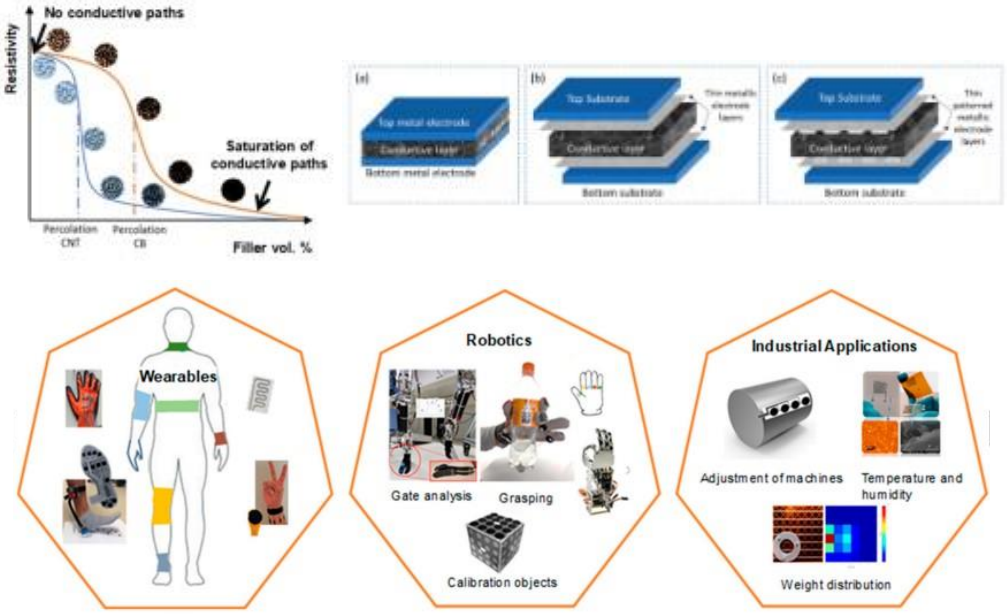
MST MEASUREMENT AND SENSOR TECHNOLOGY

Open Access Review

Review on Conductive Polymer/CNTs Nanocomposites Based Flexible and Stretchable Strain and Pressure Sensors

by Olfa Kanoun *, Ayda Bouhamed *, Rajarajan Ramalingame, Jose Roberto Bautista-Quijano, Dhivakar Rajendran and Ammar Al-Hamry

Sensors **2021**, *21*(2), 341; https://doi.org/10.3390/s21020341



Abstract

In the last decade, significant developments of flexible and stretchable force sensors have been witnessed in order to satisfy the demand of several applications in robotic, prosthetics, wearables and structural health monitoring bringing decisive advantages due to their manifold customizability, easy integration and outstanding performance in terms of sensor properties and low-cost realization. In this paper, we review current advances in this field with a special focus on polymer/carbon nanotubes (CNTs) based sensors. Based on the electrical properties of polymer/CNTs nanocomposite, we explain underlying principles for pressure and strain sensors. We highlight the influence of the manufacturing processes on the achieved sensing properties and the manifold possibilities to realize sensors using different shapes, dimensions and measurement procedures. After an intensive review of the realized sensor performances in terms of sensitivity, stretchability, stability and durability, we describe perspectives and provide novel trends for future developments in this intriguing field. View Full-Text

Keywords: polymer/CNTs nanocomposites; strain sensors; polymer/CNTs nanocomposites pressure sensors; piezoresistive; piezocapacitive; stretchability

Nanotechnology IOPscience MST MEASUREMENT AND SENSOR TECHNOLOGY

PAPER • OPEN ACCESS

Customizing hydrothermal properties of inkjet printed sensitive films by functionalization of carbon nanotubes

A Bouhamed[1], D Rajendran[1], P Frenzel[2], T Zubkova[3], A Al-Hamry[1], D Miesel[2], V Kamatchi[1], R Ramalingame[1], J R Bautista-Quijano[1], H Lang[2] + Show full author list

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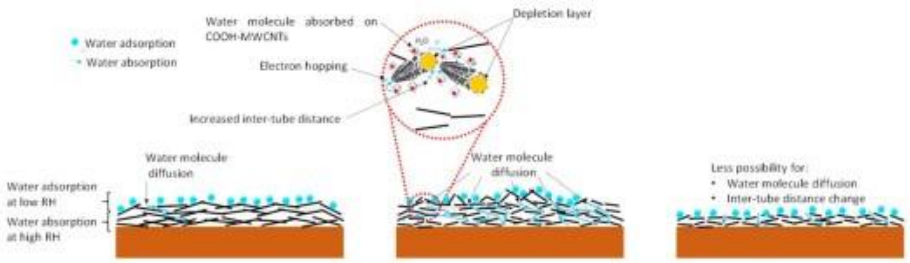
Nanotechnology, Volume 32, Number 10

Citation A Bouhamed *et al* 2021 *Nanotechnology* **32** 105708

Nanotechnology 32 105708 https://doi.org/10.1088/1361-6528/abcc95



Abstract

Multiwalled carbon nanotubes (MWCNTs) are attractive materials for realizing sensors, owing to their high aspect ratio associated with excellent mechanical, electronic, and thermal properties. Moreover, their sensing properties can be tuned by introducing functional groups on their framework and adjusting the processing conditions. In this paper, we investigate the potential of functionalized CNTs for humidity and temperature sensing by optimization of the functionalization, the processing conditions and the printing conditions. The morphology of the differently functionalized MWCNTs is investigated by infrared spectroscopy (IR), scanning electron microscopy, thermogravimetry (TG) and TG-coupled mass-spectrometric studies. Using the functionalized MWCNTs, films were fabricated with different numbers of layers (4, 6, 8, 10 layers) via inkjet printing on a flexible polyimide substrate containing an interdigital microelectrode. The influence of hydrothermal effects was investigated. The sensitivity to humidity is higher for films prepared with MWCNTs functionalized with a high sonication amplitude and a bigger number of layers due to enhancements of hydrophilicity and water mobility. A higher sensitivity to temperature is achieved by a low sonication amplitude and a small number of layers. For the encapsulation of the temperature sensor against humidity, a Bectron layer is proposed, which reduces also the hysteresis effect. This study demonstrates the efficiency of carboxylic functionalized MWCNTs deposit by inkjet printing for realization of sensitive and cost-effective humidity and temperature sensors. It provides a real example for the interesting contribution of functionalization procedures to the sensing properties of MWCNTs films.

Keywords: functionalized CNTs, inkjet printing, temperature and humidity sensing

Contents lists available at ScienceDirect

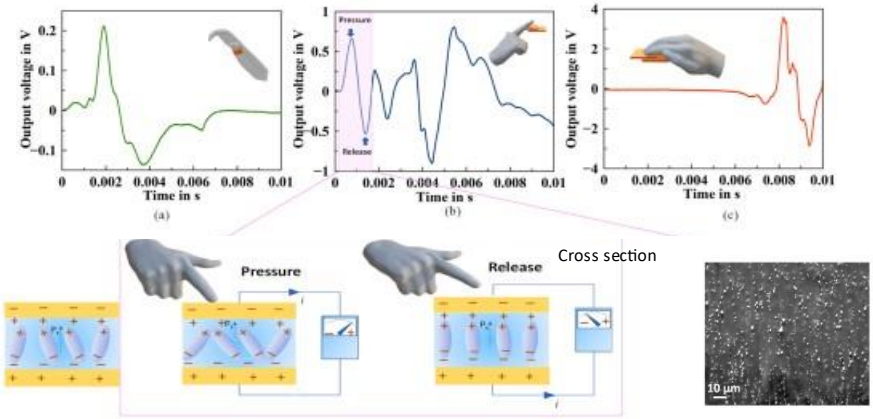
Composites Science and Technology

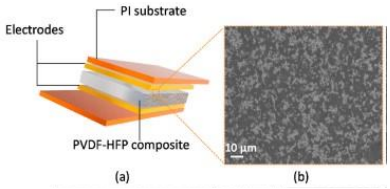
journal homepage: http://www.elsevier.com/locate/compscitech

A hybrid piezoelectric composite flexible film based on PVDF-HFP for boosting power generation

Ayda Bouhamed [a,*], Qin Binyu [a], Benny Böhm [b], Nathanael Jöhrmann [c], Nicole Behme [d], Werner A. Goedel [d], Bernhard Wunderle [c], Olav Hellwig [b], Olfa Kanoun [a]

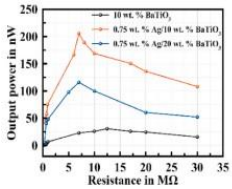
Composites Science and Technology, Volume 208, 2021, 108769, https://doi.org/10.1016/j.compscitech.2021.108769.





Abstract

Nowadays, the development of sustainable and wearable energy harvesters is gaining an increasing interest. Herein, an approach used to develop a high performance flexible nanogenerator based on hybrid piezoelectric composite is reported. The approach consists first of employing solution mixing method with different solvents to determine the suitable solvent for achieving higher piezoelectric property of the piezoceramic polymer composites. Then, integration of conductive silver nanoparticles is done to boost the performance of the nanogenerator (NG). Different aspects are considered which are the homogeneity of particles distribution within PVDF-HFP and the crystallinity of the composite using scanning electron microscopy (SEM), X-ray diffraction (XRD) and Fourier transform infrared spectroscopy (FTIR). This study demonstrates the efficiency of dimethyl formamide (DMF) solvent to increase the rate of crystalline phases due to their moderate evaporation rate and their high dipole moment that leads to enhanced piezoelectric performance. This approach proves its effectiveness to strengthen the piezoelectric performance especially by doping with silver nanoparticles (Ag NPs). The composite exhibits improved output voltage around 2.21 V and an output power of 0.22 µW, which are, respectively, around three times and 9 times higher than the composite without Ag NPs. In addition, the NG shows good stability over 900 cycles illustrating their robustness. The followed approach extends the performance limits of PVDF-HFP based NGs and their potential applications. Also, we have proved the potential of the optimized NG to harvest mechanical energy from human activities, with ability to generate around 3.56 V by striking with a palm hand.



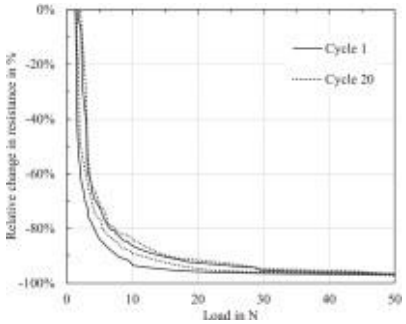
IEEE Sensors Letters OL. 5, NO. 6, JUNE 2021

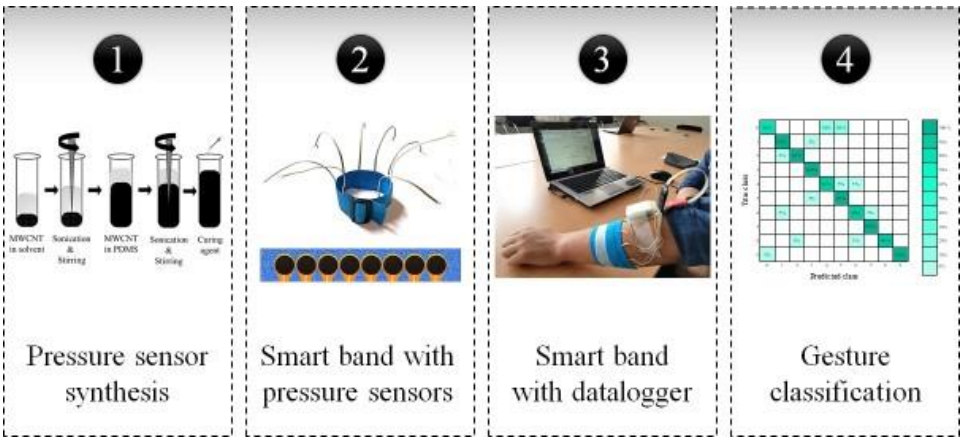
MST MEASUREMENT AND SENSOR TECHNOLOGY

Wearable Smart Band for American Sign Language Recognition With Polymer Carbon Nanocomposite-Based Pressure Sensors

Rajarajan Ramalingame[1], Rim Barioul[1], Xupeng Li[1], Giuseppe Sanseverino[2], Dominik Krumm[2], Stephan Odenwald[2], and Olfa Kanoun[1]*

IEEE Sensors Letters, vol. 5, no. 6, pp. 1-4, June 2021, Art no. 6001204,
doi: 10.1109/LSENS.2021.3081689





Abstract—The conventional camera-based systems and electronic gloves for gesture recognition are limited by the influence of lighting conditions, occlusions, and movement restrictions. A wearable smart band with integrated nanocomposite pressure sensors has been developed to overcome these shortcomings. The sensors consist of homogeneously dispersed carbon nanotubes in a polydimethylsiloxane polymer matrix prepared by an optimized synthesis process. The sensor band can actively monitor contractions/relaxations of muscles in the arm due to the sensor's high sensitivity in the low forces and stability. The band has eight sensors placed on a stretchable adhesive textile material and connected to a data logger with a multiplexed sensor interface and wireless communication capabilities. The novel smart band was validated by measurements on ten subjects to perform numerical gestures in American sign language from 0 to 9 with ten trials each. The data were recorded at 100 Hz, and a total of 100 datasets were generated for each subject. By feeding the datasets to an extreme machine learning algorithm that selects features, weights, and biases to classify the gestures, an overall gesture recognition accuracy of 93% could be achieved.

Index Terms—Sensor applications, American sign language, gesture recognition, polymer carbon nanocomposite (PCN) pressure sensors, wearable smart band.

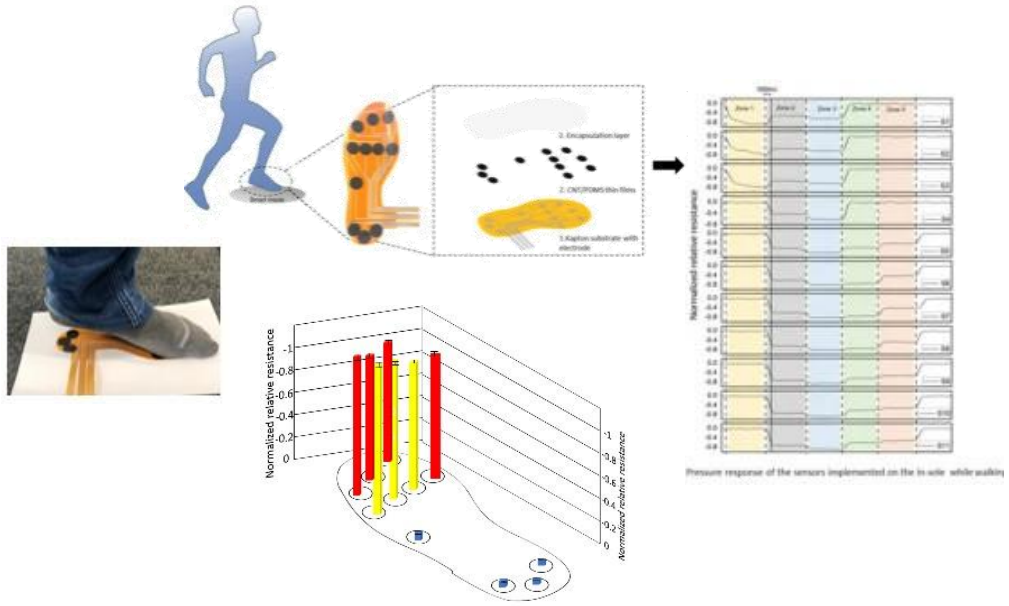
sensors MDPI MST MEASUREMENT AND SENSOR TECHNOLOGY

Open Access Article

Flexible Ultra-Thin Nanocomposite Based Piezoresistive Pressure Sensors for Foot Pressure Distribution Measurement

by Dhivakar Rajendran [1], Rajarajan Ramalingame [1], Saravanan Palaniyappan [2], Guntram Wagner [2] and Olfa Kanoun [1,*]

Sensors **2021**, *21*(18), 6082; https://doi.org/10.3390/s21186082



Abstract

Foot pressure measurement plays an essential role in healthcare applications, clinical rehabilitation, sports training and pedestrian navigation. Among various foot pressure measurement techniques, in-shoe sensors are flexible and can measure the pressure distribution accurately. In this paper, we describe the design and characterization of flexible and low-cost multi-walled carbon nanotubes (MWCNT)/Polydimethylsiloxane (PDMS) based pressure sensors for foot pressure monitoring. The sensors have excellent electrical and mechanical properties an show a stable response at constant pressure loadings for over 5000 cycles. They have a high sensitivity of 4.4 kΩ/kPa and the hysteresis effect corresponds to an energy loss of less than 1.7%. The measurement deviation is of maximally 0.13% relative to the maximal relative resistance. The sensors have a measurement range of up to 330 kPa. The experimental investigations show that the sensors have repeatable responses at different pressure loading rates (5 N/s to 50 N/s). In this paper, we focus on the demonstration of the functionality of an in-sole based on MWCNT/PDMS nanocomposite pressure sensors, weighing approx. 9.46 g, by investigating the foot pressure distribution while walking and standing. The foot pressure distribution was investigated by measuring the resistance changes of the pressure sensors for a person while walking and standing. The results show that pressure distribution is higher in the forefoot and the heel while standing in a normal position. The foot pressure distribution is transferred from the heel to the entire foot and further transferred to the forefoot during the first instance of the gait cycle. View Full-Text

Keywords: foot pressure distribution; gait analysis; flexible sensors; wearable sensors; multi carbon nanotubes (MWCNT); polydimethylsiloxane (PDMS); pressure sensor; bio-medical applications; nanocomposite sensors

Applied Physics A
Materials Science & Processing

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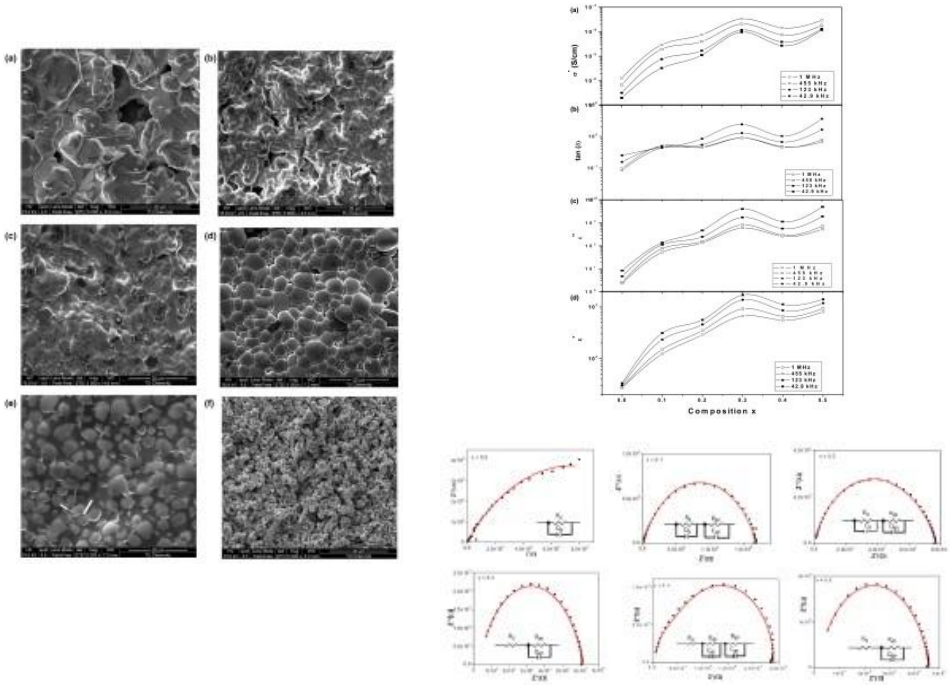
MEASUREMENT AND SENSOR TECHNOLOGY

Structural, morphological and dielectric analyses of $La_{1-x}Sr_xFeO_3$ solid solutions

R. Lataoui[1] · A. Triki[2] · S. Hcini[3] · S. Zemni[1] · J. Dhahri[4] · O. Kanoun[5]



Abstract

Dielectric and conduction properties were investigated on $La_{1-x}Sr_xFeO_3$ ($0 \le x \le 0.5$) ceramics synthesized by solid-state reaction method. X-ray powder diffraction pattern of all prepared samples and their Rietveld refinement revealed that all samples crystallize in orthorhombic structure with Pnma space group. Sr substitution induced the volume unit cell to decrease and the crystallite size to vary in a non-monotonic manner. Scanning electron microscopy images revealed also Sr-dependent morphology of the studied ceramics. Fourier transform infrared (FTIR) spectra evidenced structural distortion effects on $\nu_{Fe-O-Fe}$, $\sigma_{Fe-O-Fe}$ and ν_{La-O} vibrations and showed the presence of the carbonate ion impurity for the compositions $x = 0.2$, 0.3, 0.4 and 0.5. Ac conductivity analysis was accomplished according to equation: $\sigma_{ac}(\omega) = \frac{\sigma_s}{1+\tau^2\omega^2} + \frac{\sigma_m \tau^2 \omega^2}{1+\tau^2\omega^2} + A\omega^n$ for the parent compound and its doped one $La_{0.9}Sr_{0.1}FeO_3$. However, this analysis was realized by using Jonscher law: $\sigma_{ac}(\omega) = \sigma_{dc} + A\omega^n$ for the compositions $x = 0.2$, 0.3, 0.4 and 0.5. It revealed that the hopping process occurred through long distance for $0 \le x \le 0.3$ compositions, whereas for $x = 0.4$ and 0.5 compositions the hopping occurred between neighboring sites. Complex impedance analysis performed on these ceramics by means of different electrical equivalent circuits owing to their different morphologies allowed probing grain boundary effect on ac conductivity.

Keywords $La_{1-x}Sr_xFeO_3$ ceramics · Morphological analysis · Structural analysis · FTIR analysis · Dielectric properties · Complex impedance analysis

7 Electrochemical Sensors

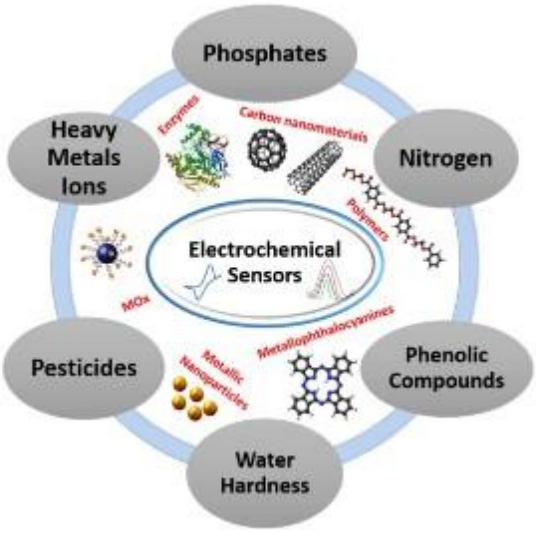
sensors MDPI MST MEASUREMENT AND SENSOR TECHNOLOGY

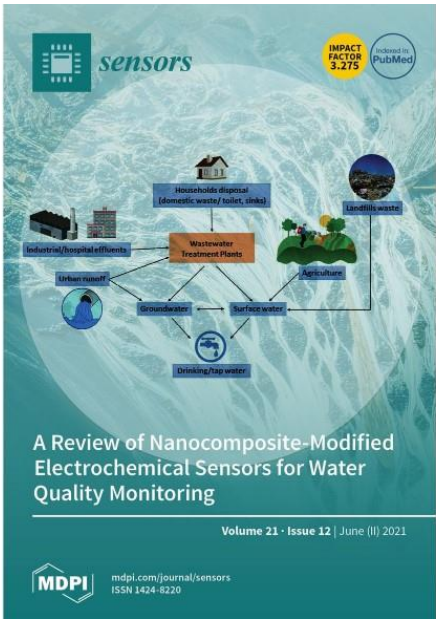
Open Access Review

A Review of Nanocomposite-Modified Electrochemical Sensors for Water Quality Monitoring

by Olfa Kanoun [1,*], Tamara Lazarević-Pašti [2], Igor Pašti [3], Salem Nasraoui [1,4,5], Malak Talbi [1,4,5], Amina Brahem [1,4,5], Anurag Adiraju [1], Evgeniya Sheremet [6], Raul D. Rodriguez [7], Mounir Ben Ali [4,5] and Ammar Al-Hamry [1]

Sensors 2021, 21(12), 4131; https://doi.org/10.3390/s21124131





Abstract

Electrochemical sensors play a significant role in detecting chemical ions, molecules, and pathogens in water and other applications. These sensors are sensitive, portable, fast, inexpensive, and suitable for online and in-situ measurements compared to other methods. They can provide the detection for any compound that can undergo certain transformations within a potential window. It enables applications in multiple ion detection, mainly since these sensors are primarily non-specific. In this paper, we provide a survey of electrochemical sensors for the detection of water contaminants, i.e., pesticides, nitrate, nitrite, phosphorus, water hardeners, disinfectant, and other emergent contaminants (phenol, estrogen, gallic acid etc.). We focus on the influence of surface modification of the working electrodes by carbon nanomaterials, metallic nanostructures, imprinted polymers and evaluate the corresponding sensing performance. Especially for pesticides, which are challenging and need special care, we highlight biosensors, such as enzymatic sensors, immunobiosensor, aptasensors, and biomimetic sensors. We discuss the sensors' overall performance, especially concerning real-sample performance and the capability for actual field application. View Full-Text

Keywords: electrochemical sensor; water contaminants; pesticides; inorganic compounds; emergent contaminants; in-situ applications; impedance spectroscopy; square wave voltammetry

Contents lists available at ScienceDirect

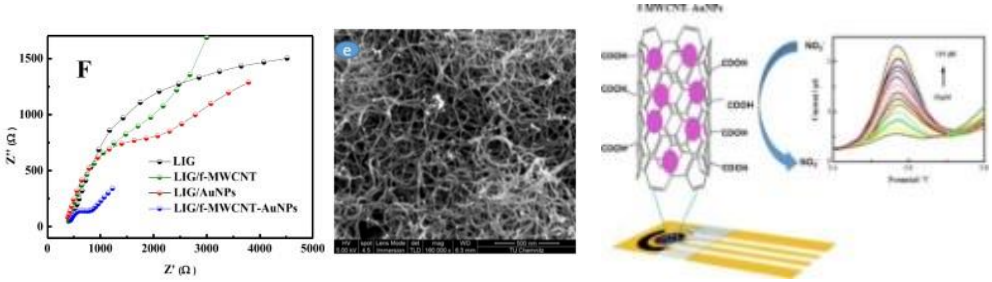
Journal of Electroanalytical Chemistry

journal homepage: www.elsevier.com/locate/jelechem

Electrochemical sensor for nitrite detection in water samples using flexible laser-induced graphene electrodes functionalized by CNT decorated by Au nanoparticles

Salem Nasraoui [a,b,*], Ammar Al-Hamry [a], Priscila Rios Teixeira [c], Sami Ameur [b,d], Leonardo G. Paterno [c], Mounir Ben Ali [e], Olfa Kanoun [a]

Journal of Electroanalytical Chemistry, Volume 880, 2021, 114893, https://doi.org/10.1016/j.jelechem.2020.114893.



Abstract

This paper reports on a sensitive, selective and reproducible electrochemical sensor for nitrite detection based on laser-induced graphene (LIG) electrode patterned onto a flexible poly(imide) substrate and further modified by COOH functionalized multiwalled carbon nanotubes (f-MWCNT) and gold nanoparticles (AuNPs) films. According to Raman spectroscopy, photoluminescence spectroscopy and scanning electron microscopy, the laser induced photothermal reactions produce ultrathin graphene-like sheets emerging from the substrate, which stay connected to the surface forming a three-dimensional microporous structure. This process permits to scribe in a single step and mask-free, working, counter and reference electrodes on a polymeric substrate. Cyclic voltammetry and electrochemical impedance spectroscopy performed in ferri-ferrocyanide redox pair show that the electroactive area of LIG modified by f-MWCNT- AuNPs is increased and the charge-transfer resistance is diminished in comparison to the modification by each nanomaterial alone. The sensor has a linear characteristic (R^2 = 0.996) in the nitrite concentration range from 10 µM to 140 µM and a limit of detection of 0.9 µM following the 3Sb/m method. In presence of typical interfering ions, added in 100-fold excess, the sensor shows a relative standard deviation less than 10%. The results show that a single LIG/f-MWCNT-AuNPs electrode can perform electrochemical detection of nitrite for at least seven consecutive runs with a low signal variation of 2.63% corresponding to a nitrite concentration of 90 µM. Furthermore, seven different electrodes fabricated in the same batch performed identically, with a low signal variation of 2.80% corresponding to a nitrite concentration of 90 µM.

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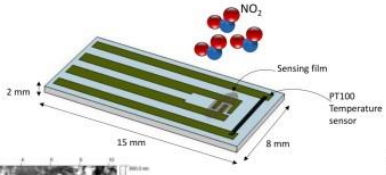
Article

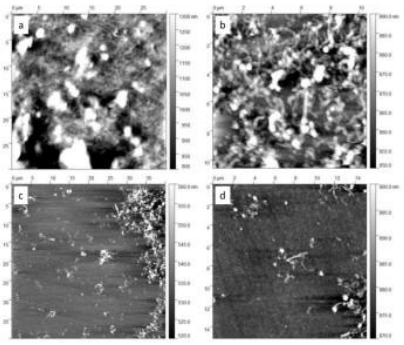
Modeling the Conductivity Response to NO_2 Gas of Films Based on MWCNT Networks

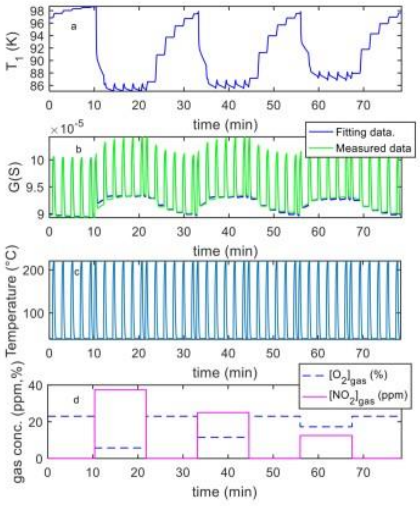
Ada Fort [1,*], Marco Mugnaini [1], Enza Panzardi [1], Anna Lo Grasso [1], Ammar Al Hamry [2], Anurag Adiraju [2], Valerio Vignoli [1] and Olfa Kanoun [2]

Sensors **2021**, *21*(14), 4723; https://doi.org/10.3390/s21144723

$$G = \frac{1}{R_B} exp\left(-\frac{T_1}{\nu T_1^{3/4} + T}\right)$$







	MWCNT-COOH	MWCNT-COOH	MWCNT-COOH + Au
k_2 (s^{-1}) (@ 25 ppm NO_2)	9.4	9.4	18
k_{0NO_2} (s^{-1})	6.1×10^6	6.1×10^6	7.06
λ_{NO_2} (K)	3188	3188	2752
λ_{iNO_2} (K)	9182	9182	2800
$[S]'$ ($K^{1/2}$)	0.97	0.97	1.68
T_{01} (K)	95	95	114
η ($K^{1/4}$)	0.3	0.3	0.04
R_B (W)	12,145	12,145	11,944

Abstract

This work proposes a model describing the dynamic behavior of sensing films based on functionalized MWCNT networks in terms of conductivity when exposed to time-variable concentrations of NO_2 and operating with variable working temperatures. To test the proposed model, disordered networks of MWCNTs functionalized with COOH and Au nanoparticles were exploited. The model is derived from theoretical descriptions of the electronic transport in the nanotube network, of the NO_2 chemisorption reaction and of the interaction of these two phenomena. The model is numerically implemented and then identified by estimating all the chemical/physical quantities involved and acting as parameters, through a model fitting procedure. Satisfactory results were obtained in the fitting process, and the identified model was used to further the analysis of the MWCNT sensing in dynamical conditions. View Full-Text

Keywords: MWCNT NO_2 sensing; CNT gas sensing analytical model; gas sensing conductivity model; functionalized MWCNT; Au nanoparticles

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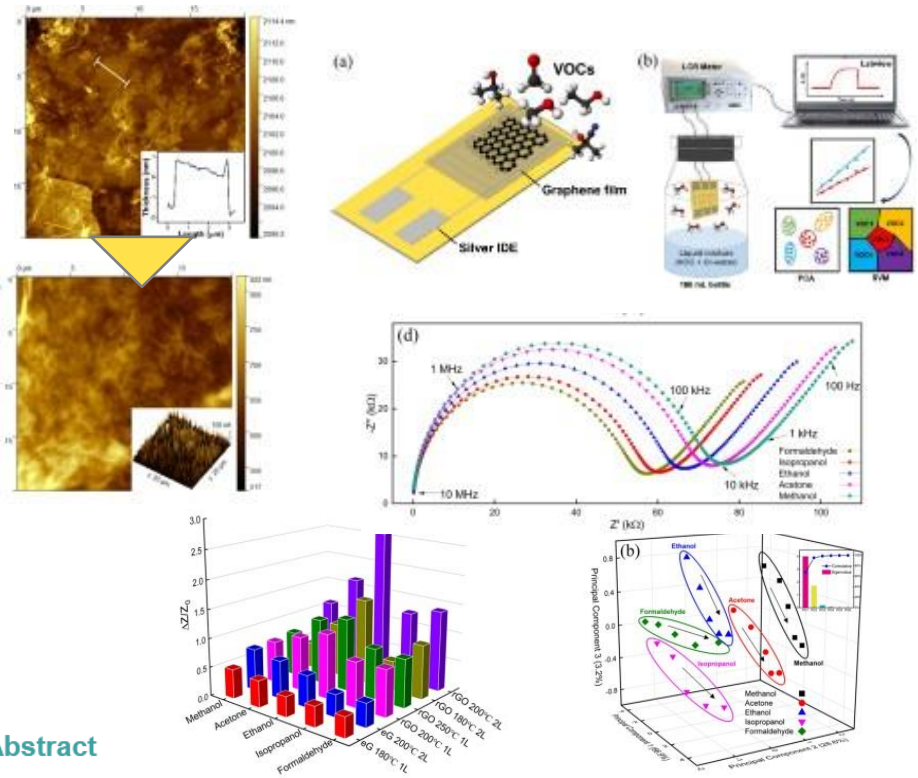
Article

Flexible Impedimetric Electronic Nose for High-Accurate Determination of Individual Volatile Organic Compounds by Tuning the Graphene Sensitive Properties

Tianqi Lu [1,†], Ammar Al-Hamry [1,*,†], José Mauricio Rosolen [2], Zheng Hu [1], Junfeng Hao [1], Yuchao Wang [1], Anurag Adiraju [1], Tengfei Yu [1], Elaine Yoshiko Matsubara [2] and Olfa Kanoun [1,*]

*Chemosensors***2021**, *9*(12), 360; https://doi.org/10.3390/chemosensors9120360



Abstract

We investigated functionalized graphene materials to create highly sensitive sensors for volatile organic compounds (VOCs) such as formaldehyde, methanol, ethanol, acetone, and isopropanol. First, we prepared VOC-sensitive films consisting of mechanically exfoliated graphene (eG) and chemical graphene oxide (GO), which have different concentrations of structural defects. We deposited the films on silver interdigitated electrodes on Kapton substrate and submitted them to thermal treatment. Next, we measured the sensitive properties of the resulting sensors towards specific VOCs by impedance spectroscopy. We obtained the eG- and GO-based electronic nose composed of two eG films- and four GO film-based sensors with variable sensitivity to individual VOCs. The smallest relative change in impedance was 5% for the sensor based on eG film annealed at 180 °C toward 10 ppm formaldehyde, whereas the highest relative change was 257% for the sensor based on two-layers deposited GO film annealed at 200 °C toward 80 ppm ethanol. At 10 ppm VOC, the GO film-based sensors were sensitive enough to distinguish between individual VOCs, which implied excellent selectivity, as confirmed by Principle Component Analysis (PCA). According to a PCA-Support Vector Machine-based signal processing method, the electronic nose provided identification accuracy of 100% for individual VOCs. The proposed electronic nose can be used to detect multiple VOCs selectively because each sensor is sensitive to VOCs and has significant cross-selectivity to others.

View Full-Text

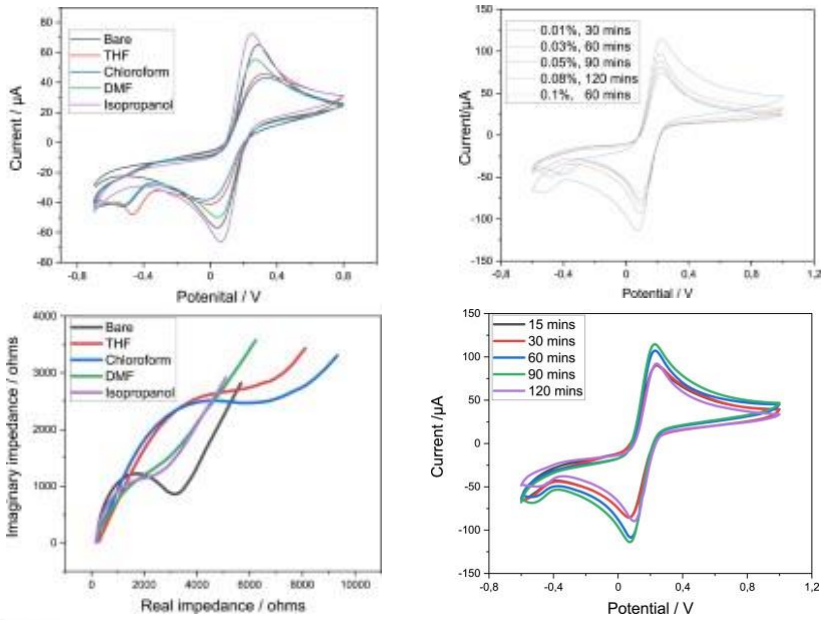
Keywords: graphene; reduced graphene oxide; electronic nose; VOC sensor; sensor array; impedance spectroscopy; PCA; SVM

Measurement: Sensors
Volume 18, December 2021, 100335

Effect of MWCNT dispersion parameters on the performance of electrochemical sensors

Adiraju Anurag ✉, Shuo Niu ✉, Olfa Kanoun ✉

Measurement: Sensors, Volume 18, 2021, 100335
https://doi.org/10.1016/j.measen.2021.100335



Abstract

The use of Multiwalled carbon nanotubes (MWCNTs) as surface modification material for electrochemical sensors is gaining importance. Thereby, the performance of the MWCNT modified sensors is dependent on the preparation parameters of the MWCNT dispersion, which should ensure a good homogeneity, an increased surface area and an enhancement of electrocatalytic activity. In this study, we investigate the performance of commercial screen-printed electrodes modified with MWCNTS by varying the sonication time, solvent type and concentrations. The performance of the modified electrodes is investigated by using a standard redox couple and the best parameters are determined. The results show that using isopropanol as solvent with a MWCNT concentration of 0.05% treated for 90 minutes by sonication leads to the best performance.

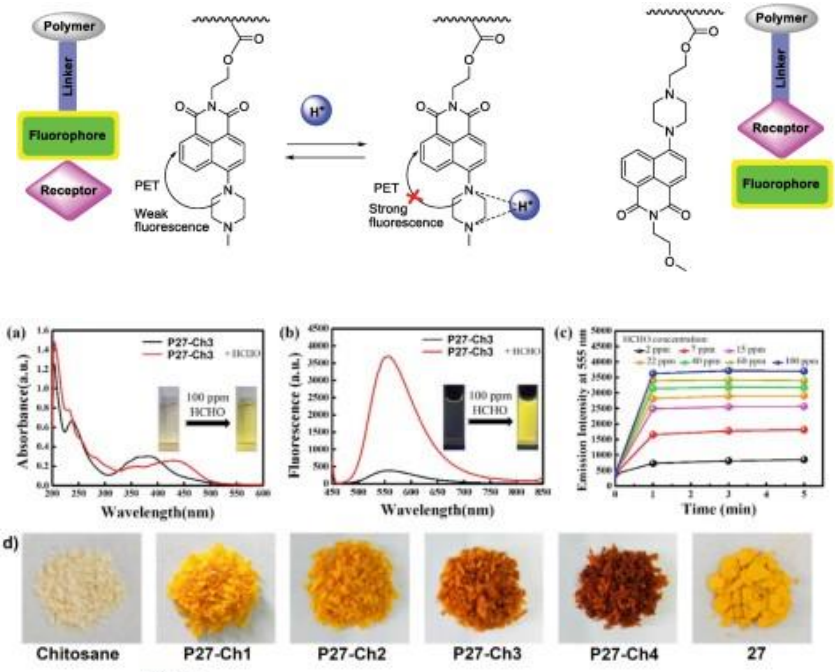
ADVANCED OPTICAL MATERIALS

REVIEW

MST MEASUREMENT AND SENSOR TECHNOLOGY

Naphthalimide-Based Fluorescent Polymers for Molecular Detection

Aleksandr S. Oshchepkov, Maxim S. Oshchepkov, Margarita V. Oshchepkova, Ammar Al-Hamry, Olfa Kanoun, and Evgeny A. Kataev**

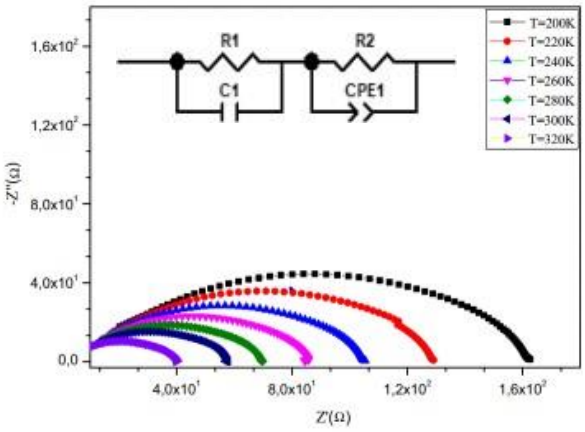


The beginning of the 21st century was marked by the intensive development of fiber-optic sensors. New functional materials with excellent sensory properties are required to design such sensors. Fluorescent probes for neutral and charged molecules are constantly developing. However, only a small part of the reported probes was successfully converted into functional sensing polymers and found real-world applications. A great challenge is to retain the sensing properties of a probe in a polymer matrix. The purpose of this review is to understand how properties of a probe are changed upon incorporation into a polymer and to reveal successful approaches. The review focuses on the use of the naphthalimide-based probes in the construction of sensing polymers. The literature overview is presented according to the nature of the guest molecules targeted for the quantitative detection: cations, anions, and small organic molecules.

J Mater Sci: Mater Electron

Investigation of AC electrical conductivity and dielectric properties of $BiBaFeZnO_6$ double perovskite oxides

K. Iben Nassar[1], M. Slimi[1,2], N. Rammeh[1,*], A. Bouhamed[3], A. Njeh[1], and O. Kanoun[3]



ABSTRACT

Double perovskites are currently being intensively studied thanks to their highly relevant technological potential as materials with manifold properties. This contribution aims to the preparation of double perovskite oxide material $BiBaFeZnO_6$, which is synthesized by the sol–gel method. The structural study shows that the sample is single phase and crystallizes in the rhombohedral system with the $R\bar{3}C$ space group. In addition, impedance spectroscopy was used to study the dielectric behavior of materials and the different physical phenomena at temperature range from 200 to 380 K and in a frequency range up to 1 MHz. The Nyquist diagram at different temperatures reveals the behavior of flat semi-circular, which has been modeled by an equivalent circuit including an RC element and an RQ element. The frequency-dependent behavior of Z″ shows a peak inferring a relaxation. The electrical conductivity was determined by the Jonscher's law, and the activation energy were calculated from modulus or DC conductivity. The obtained results have confirmed that the non-overlapping small polaron tunneling model (NSPT) is the appropriate model to explain the electrical conduction phenomenon.

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