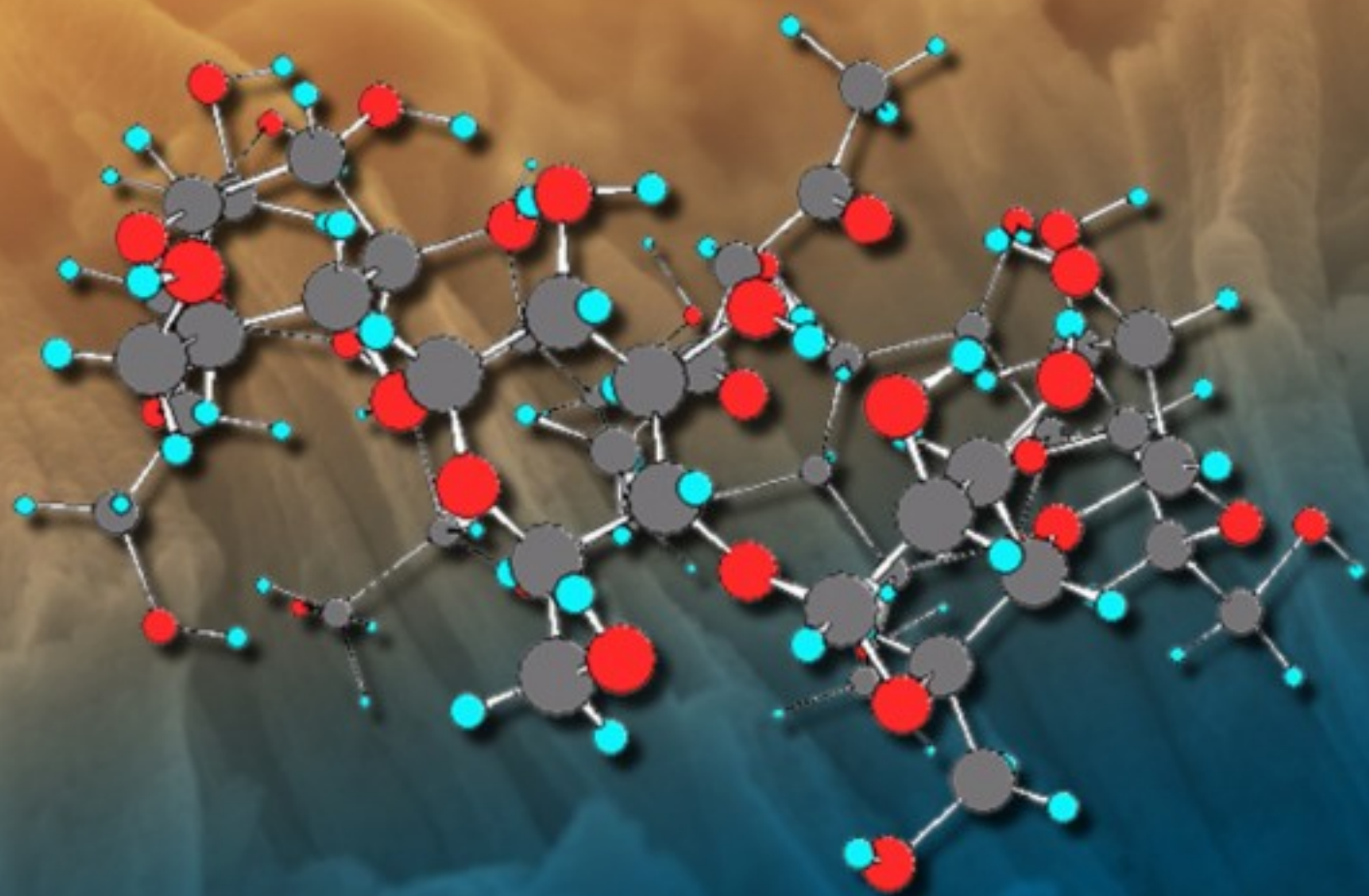


ISSN 1726-5479

SENSORS **11** vol. 146 & TRANSDUCERS **/12**



Nanosensors and Nanodevices

International Frequency Sensor Association Publishing





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Issue 11
November 2012

www.sensorsportal.com

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Development of Electrochemical Sensors for the Detection of Mercury by CNT/Li⁺, C₆₀/Li⁺ and Activated Carbon Modified Glassy Carbon Electrode in Blood Medium

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Received: 30 June 2012 /Accepted: 23 November 2012 /Published: 30 November 2012

Abstract: An electrochemical investigation of mercury species has been carried out by using cyclic voltammetry (CV) at different modified electrodes. The doping of the Li⁺ ion onto the modified glassy carbon electrode (GCE) with carbon nanotubes CNT and C₆₀ was carried out to 10 potential cycling in the presence of 0.1 M LiOH. The modified CNT/Li⁺/GCE, C₆₀/Li⁺/GCE and modified activated carbon (AC) on GCE as AC/GCE were used as working electrodes and applied for the detection of Hg(II) ion in blood medium using cyclic voltammetry (CV) technique. Electrodes response was obtained for the oxidation peak of 0.1 mM of Hg(II) ion in 0.1 M KCl at lithium doped modified CNT/GCE, C₆₀/GCE, and only AC/GCE. A well defined oxidation peak appeared at +0.8 V vs. Ag/AgCl with a current enhancement and peak potential shift toward higher potential due to nano materials (CNT and C₆₀) and presence of Lithium doped comparison with CNT/GCE, C₆₀/GCE, and only AC/GCE. Besides that, the presence of CNT with Lithium doped in blood media caused an increase of the oxidation peak of Hg(II) ion (current enhancement) by about three times compared to use of other modified electrodes. A linear relationship ($R^2=0.986$, $Y=26.60X+12.10$ and $RSD= \pm 2.4 \%$) was observed for the plot of current (μA) versus concentration range of 3×10^{-3} - 6×10^{-2} M of Mercury in blood media using CNT and Lithium doped modified GCE. Based on the background noise of 50 data points, adjacent to the oxidation peak of Hg(II), and $3\sigma/\text{slope}$, a detection limit of 3×10^{-3} M was determined. So it can be said that these modified electrodes could be used as good sensors in CV for the detection of traces of mercury in blood medium. *Copyright* © 2012 IFSA.

Keywords: Sensors, Blood medium, Hg(II), CNT/Li⁺/GCE, C₆₀/Li⁺/GCE, AC/GCE.

1. Introduction

Heavy metals such as cadmium (Cd), lead (Pb), and mercury (Hg) are highly toxic materials. Due to their extreme toxicity, these metals must be detected at very low levels in biological fluids such as blood and urine. Microanalytical based sensors that work with complex biomatrices such as blood, urine, or saliva are being developed and validated and will improve our ability to make definitive associations between chemical exposures and disease. Hg-free metal analyzers employing adsorptive stripping voltammetry and novel nanostructure materials that include the self-assembled monolayers on mesoporous supports and carbon nanotubes. These sensors have been optimized to detect Pb(II) in urine, blood, and saliva as accurately as the state-of-the-art inductively coupled plasma-mass spectrometry, with mutual high reproducibility, and sensitivity allows. The heavy metal mediated toxicity has been linked to diseases like Alzheimer's, Parkinson's, Autism, Lupus, Amyotrophic lateral sclerosis, etc. Besides this, it poses danger to wildlife. Therefore, it becomes imperative to spread the information regarding the threat of mercury exposure amongst the scientists and masses [1-4].

Nanomaterials have become an extremely popular theme in recent electrochemical sensing research, due to their electrical conductivity, unique structural and catalytic properties, high loading of biocatalysts, good stability and excellent penetrability. Carbon nanotubes (CNTs) can be used as electrode materials with useful properties for various potential applications including miniature biological devices. These sensors achieved higher response current, low work potential and low interference. Carbon nanotube was used to modify glassy carbon electrode sensor, which performed the electroreduction at a low operating potential. In general, voltammetric sensors examine the concentration effect of the detecting species on the current-potential characteristics of the reduction or oxidation reaction involved [5-7].

The electrochemical determination of trace Hg^{2+} using gold nanoparticles–modified glassy carbon (AuNPs–GC) electrodes is described in cyclic voltammetry (CV). AuNPs were characterized as a function of the charge using both CV in H_2SO_4 and scanning electron microscopy (SEM). The AuNPs–GCE was then applied to determine low Hg^{2+} concentrations using square wave anodic stripping voltammetry. The AuNPs–GC electrodes provided significantly improved performances in Hg^{2+} determination compared to unmodified GC and bare Au electrodes. It was shown that the physico-chemical properties of the deposits are correlated to the performances of the AuNPs–GC electrode with respect to Hg^{2+} assay. The best results were obtained for four electrode position cyclic scans, small-sized particles (36 ± 13 nm) with high density (73 particles μm^{-2}) [8].

The oxidative electropolymerization of the (3-pyrrol-1-ylpropyl)malonic acid monomer is a simple and reproducible one-step procedure for the synthesis of complexing polymer film modified electrodes, which have been applied to the electroanalysis of Cu(II), Pb(II), Cd(II) and Hg(II) ions by preconcentration upon complexation, followed by anodic stripping analysis. The detection limits were determined from square-wave voltammetry at 0.5 nM, 5 nM, 50 nM and 0.2 μM for Pb(II), Cu(II), Hg(II) and Cd(II), respectively, after 10 min preconcentration. The modified electrodes showed a better selectivity toward copper (II) ions [9].

CNTs play an important role in the performance of electrochemical biosensors, immunosensors, and DNA biosensors. Various methods have been developed for the design of sensors using CNTs in recent years. The applications of CNTs in the construction of electrochemical sensors and biosensors along with other nanomaterials and conducting polymers [10, 11].

Electrochemical sensors have great potential for environmental monitoring of toxic metal ions in waters due to their portability, field-deployability and excellent detection limits. However, electrochemical sensors employing mercury-free approaches typically suffer from binding competition

for metal ions and fouling by organic substances and surfactants in natural waters, making sample pretreatments such as wet ashing necessary. The potentially confounding factors affecting metal detection at self-assembled monolayers on mesoporous supports Nafion electrodes were studied, including pH effect, transport resistance of metal ions, and detection interference. With the ability to reliably detect low metal concentration ranges without sample pretreatment and fouling, the sensors have the potential to become the next generation metal analyzers for environmental and bio-monitoring of toxic metals [12].

In this work, CNT/Li⁺, C₆₀/Li⁺ and AC were modified GCE by mechanical and solution evaporation methods to resulting as good sensors for detecting traces of Hg²⁺ in blood medium by cyclic voltammetric technique [13].

2. Experimental

2.1. Materials

C₆₀ (Fluka, 98 %), CNT (Fluka, 98 %) and AC (Fluka, 99 %). Blood samples were used from healthy mice. Other chemicals and solvents were of annular grade and used as received from the manufacturer. Distilled water was used for the preparation of aqueous solutions. All solutions were deaerated with oxygen free nitrogen gas for 15 min prior to making the measurement.

2.2. Instruments

Electrochemical workstations of Bioanalytical system Inc. USA: Model BAS CV 50 W with potentiostat driven by electroanalytical measuring software was connected to a PC to perform Cyclic Voltammetry (CV). An Ag/AgCl (3M NaCl) and Platinum wire (1 mm diameter) were used as a reference and counter electrode respectively [14]. The working electrodes used in this study were modified CNT and AC by doping GCE with CNT by mechanical method [15, 16], also the C₆₀ has evaporated on the GCE [17]. C₆₀/Li⁺/GCE and CNT/Li⁺/GCE were prepared by the doping of Li⁺ ion on to C₆₀/GCE and CNT/GCE via 10 potential cycling between +600 to -600 mV in presence of 0.1 M LiOH during cyclic voltammetry.

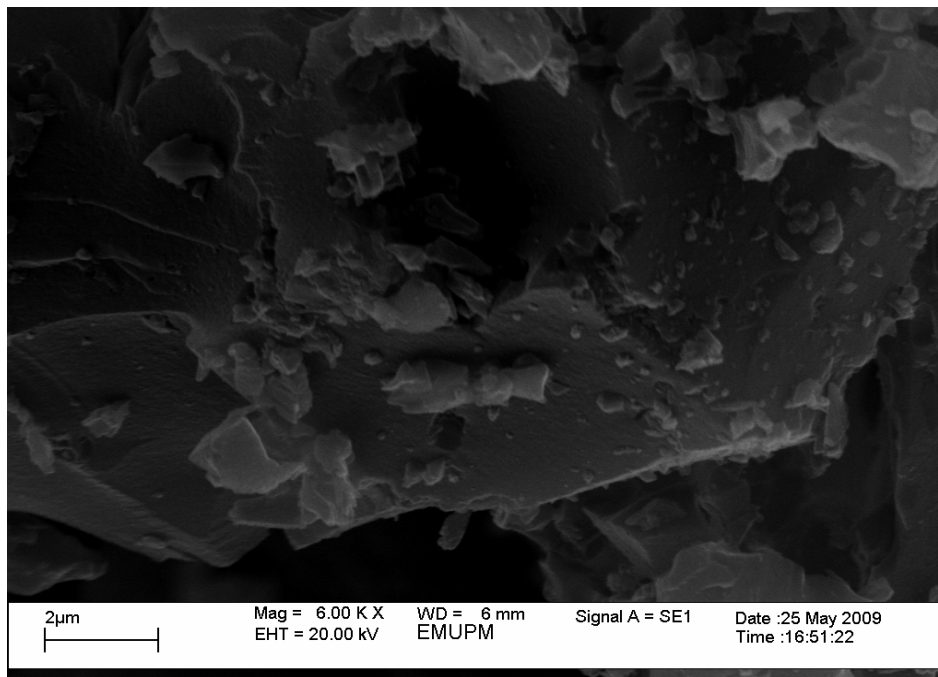
2.3. Electrodes

A Mechanical Attachment technique (MA): was used which involved the pressing of a clean GCE surface onto a few mg of CNT powder or AC powder placed on a filter paper. Solution evaporation technique: This method includes application of a 2 μL of saturated C₆₀ in acetonitrile and subsequently dried by hot air blower before placing in voltammetric cell.

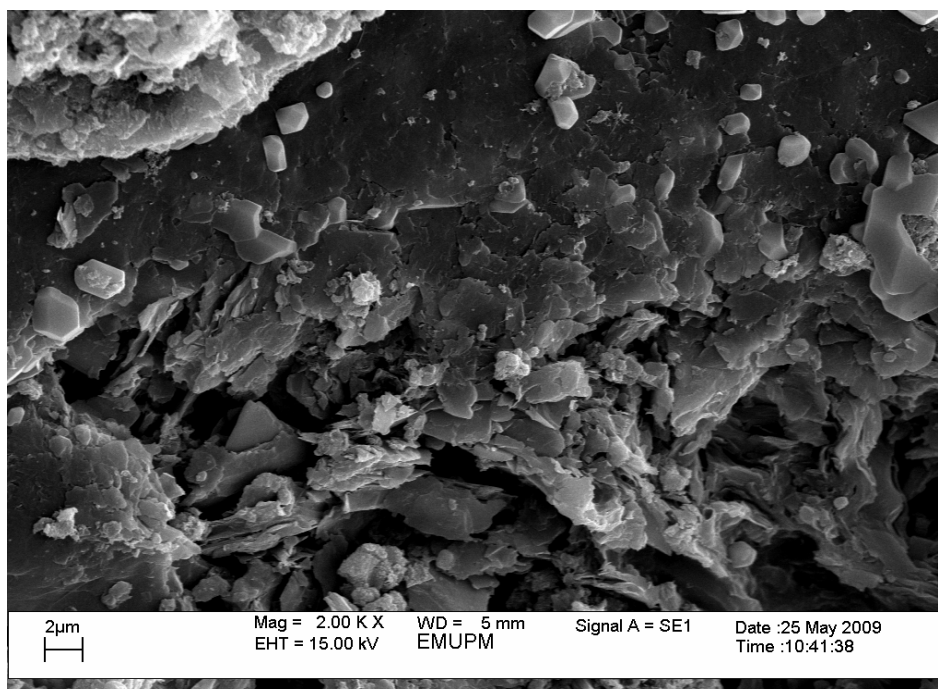
2.4. Scanning Electron Microscopy (SEM)

SEM of the fractured surfaces of the nanocomposites were studied using a JEOL attached with Oxford Inca Energy 300 EDXFEL scanning electron microscope operated at 20-30 kV. The scanning electron photographs were recorded at a magnification of 1000-6000X depending on the nature of the sample. SEM analysis was carried out to investigate microcrystals. Samples were dehydrated for 45 min before being coated with gold particles using SEM coating unit baltec SC030 sputter Coater. Scanning Electron Microscopy (SEM) was used to examine the morphology of CNT, C₆₀ and AC microcrystals by mechanically attached and evaporated technique on a graphite electrode surface before and after

electrolysis with Hg(II) by cyclic voltammetry. Fig. 1a, 2a and 3a are SEM of CNT, C₆₀ and AC respectively, attached and evaporated before electroanalysis with ions on to a 6 mm diameter basal plane graphite electrode which exhibits an array of microcrystals with 0.1-2 μm diameter. Fig. 1b, 2b and 3b are SEM of CNT, C₆₀ and AC respectively, on a graphite electrode after electroanalysis with Hg(II).

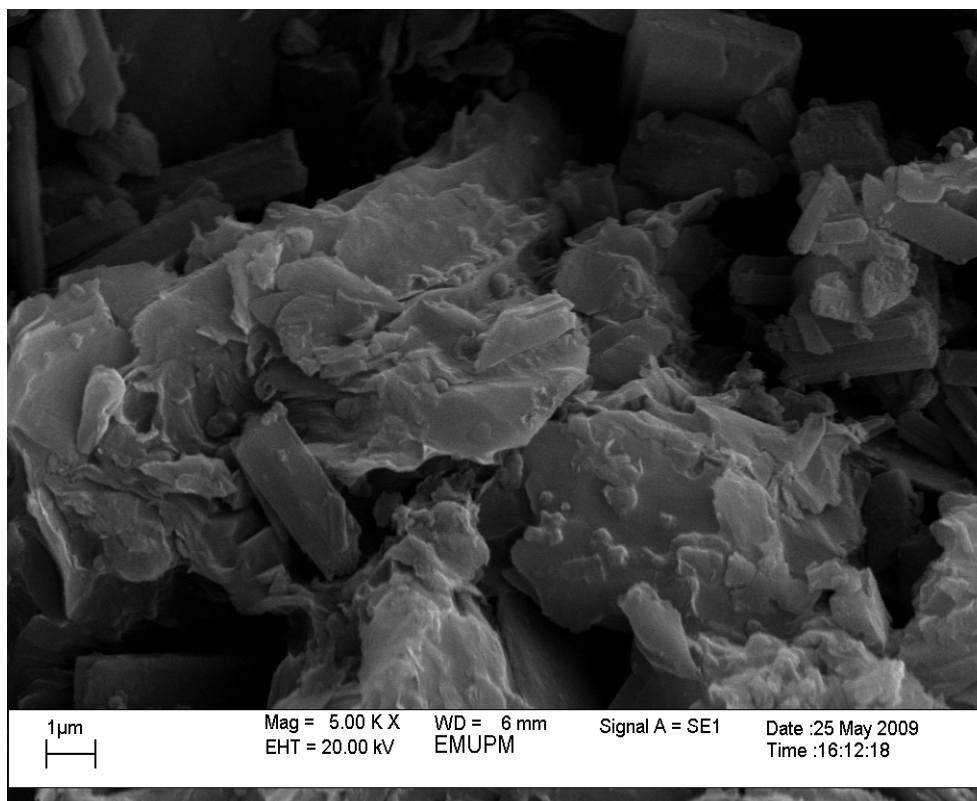


(a)

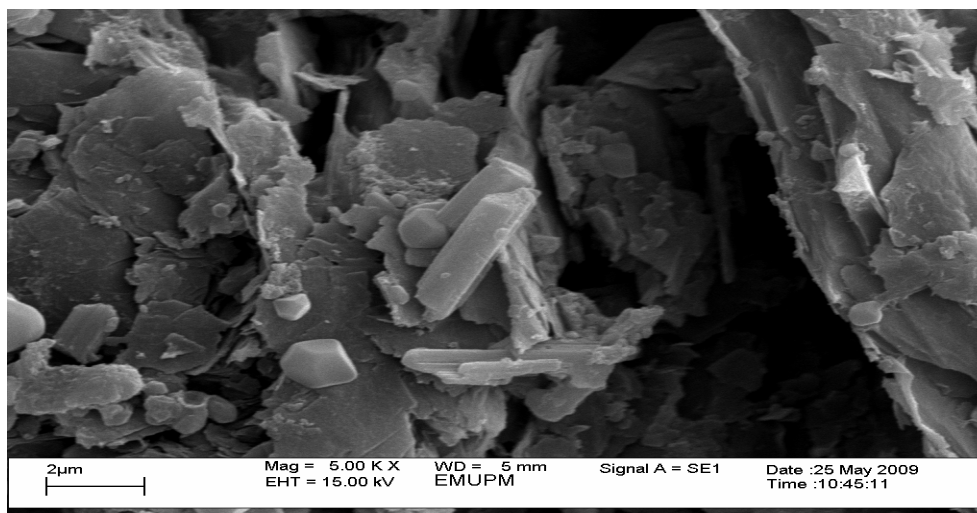


(b)

Fig. 1. Scanning electron micrographs of CNT microparticles mechanically attached to a basal plane pyrolytic graphite electrode (a) before, and (b) after electroanalysis with Hg(II).

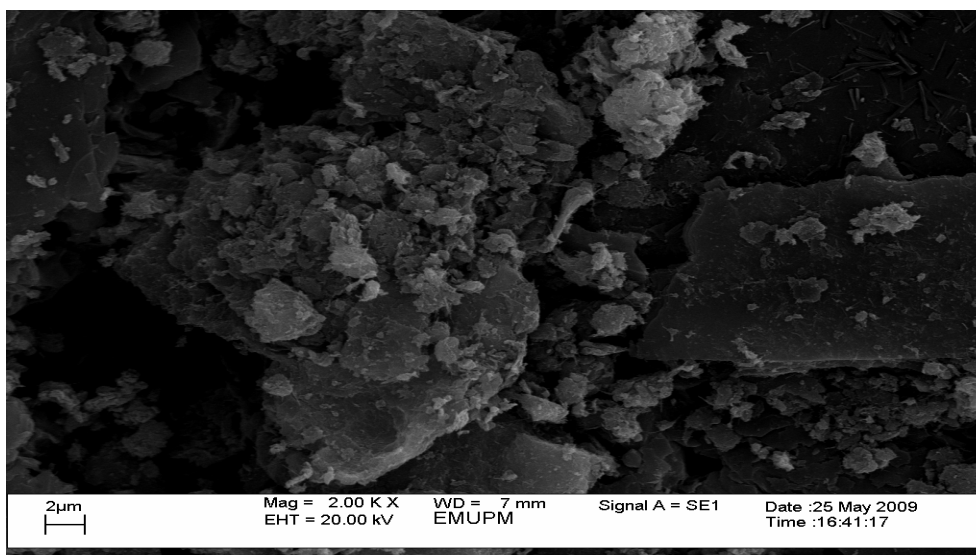


(a)

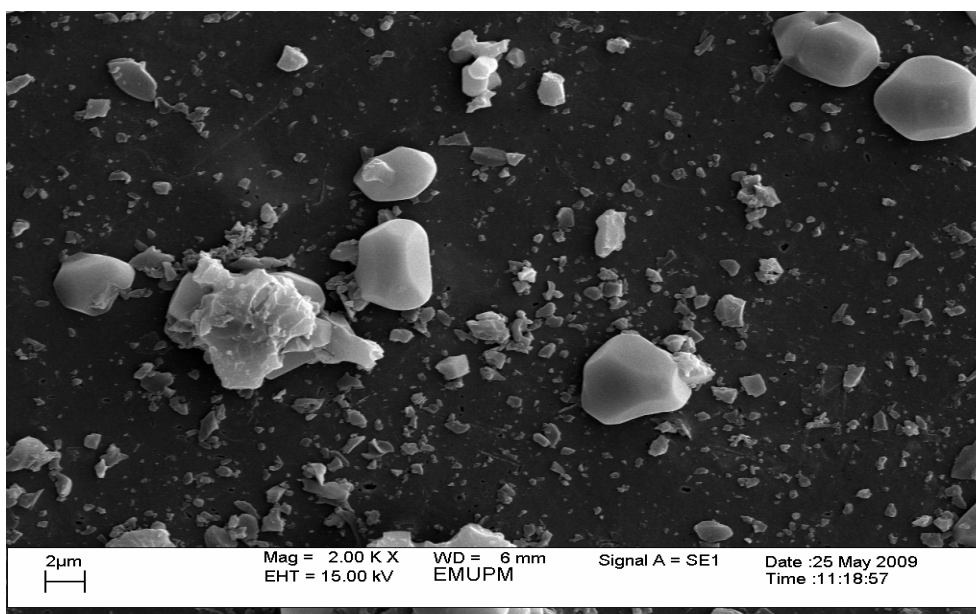


(b)

Fig. 2. Scanning electron micrographs of C_{60} microparticles mechanically attached to a basal plane pyrolytic graphite electrode (a) before, and (b) after electroanalysis with $Hg(II)$.



(a)



(b)

Fig. 3. Scanning electron micrographs of AC microparticles mechanically attached to a basal plane pyrolytic graphite electrode (a) before, and (b) after electroanalysis with Hg(II).

3. Results and Discussion

3.1. Effect of Different Modified Electrodes

Fig. 4 shows the oxidation peak of Hg(II) was considerably enhanced by 4-5 times when modified GCE as C₆₀/Li⁺/GCE, CNT/Li⁺/GCE and AC/GCE were used in comparison with GCE in KCl as supporting electrolyte. Evidently the degree of sensitivity response increases in the order of:



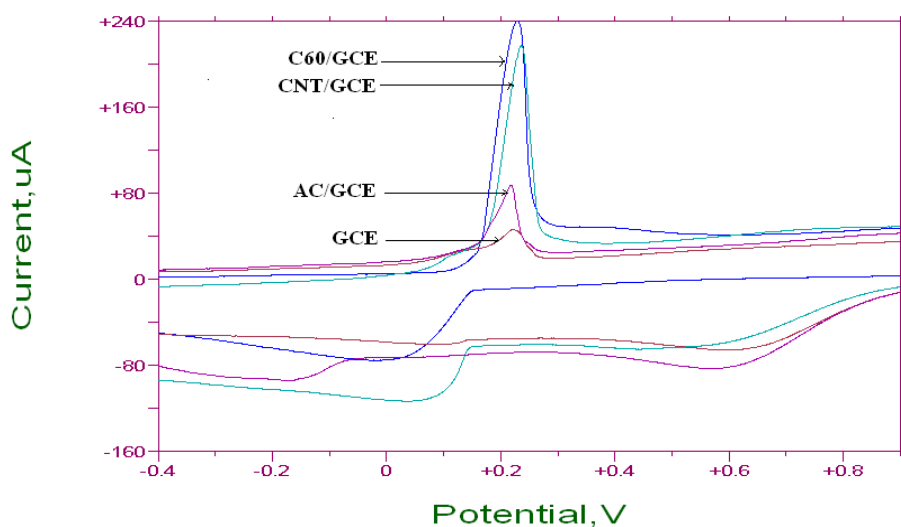


Fig. 4. Voltammograms for the redox current at different modified GCE in 1mM Hg(II) with 0.1 M KCl as supporting electrolyte versus Ag/AgCl as reference electrode and scan rate 100 mVsec⁻¹.

Fig. 5 shows the result confirms that electro-catalytic activity of CNT/Li⁺, C₆₀/Li⁺ and AC with attendance of blood was exerted on the oxidation peak of Hg(II) under the conditions of cyclic voltammetry. The degree of sensitivity/electro-catalytic response for the different electrodes in blood increases in the order of:

$$\text{CNT/Li}^+/\text{GCE} > \text{C}_{60}/\text{Li}^+/\text{GCE} > \text{AC/GCE}$$

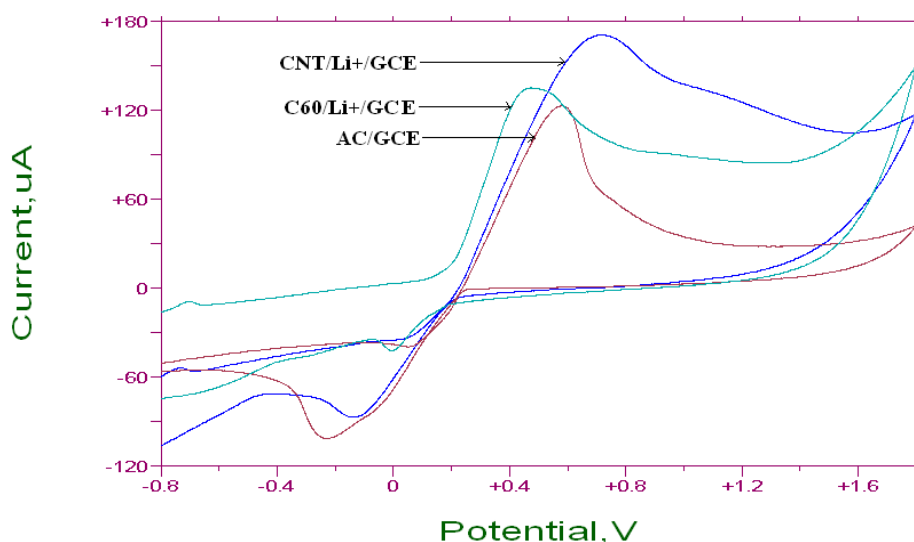


Fig. 5. Voltammograms for the redox current at different modified GCE(CNT/Li⁺/GCE, C₆₀/Li⁺/GCE and AC/GCE) in 1mM Hg(II) with blood sample as supporting electrolyte versus Ag/AgCl as reference electrode and scan rate 100 mVsec⁻¹.

The oxidation peak of Hg²⁺ in blood media appeared more discernible when the CNT/Li⁺/GCE was used compared to C₆₀/Li⁺/GCE and AC/GCE. Oxidation peak becomes even more pronounced and enhanced by two times at the electrode surface of the CNT/Li⁺/GCE. The oxidation peak of Hg(II) ion is irreversible, since there is an absence of electro-activity on the reversal/oxidative scan during cyclic voltammetry for the other modified electrodes. The electro-catalytic effect appeared more enhanced

since the Li^+ dopant would increase the conductivity of the electrode surfaces. Since the CNT/ Li^+ /GCE is a more sensitive electrode, it was used for subsequent optimization studies such as a sensation of heavy metal ions in blood samples esp. Hg(II).

3.2. Applications of Electrochemical Sensors in Blood Analysis

The CNT/ Li^+ /GCE exhibited an excellent performance for Hg(II) analysis as shown in Fig. 6. A well-defined curve was observed at +400 mV corresponding to the oxidation peak of Hg(II). The calibration plots were performed on the CNT/ Li^+ /GCE within the concentration range of 3×10^{-3} - 6×10^{-2} M for the Hg(II) in blood sample as shown in Fig. 7 with a correlation coefficient of $R^2=0.986$, $Y=26.60x+12.10$ and good results of $\text{RSD} \pm 2.4 \%$.

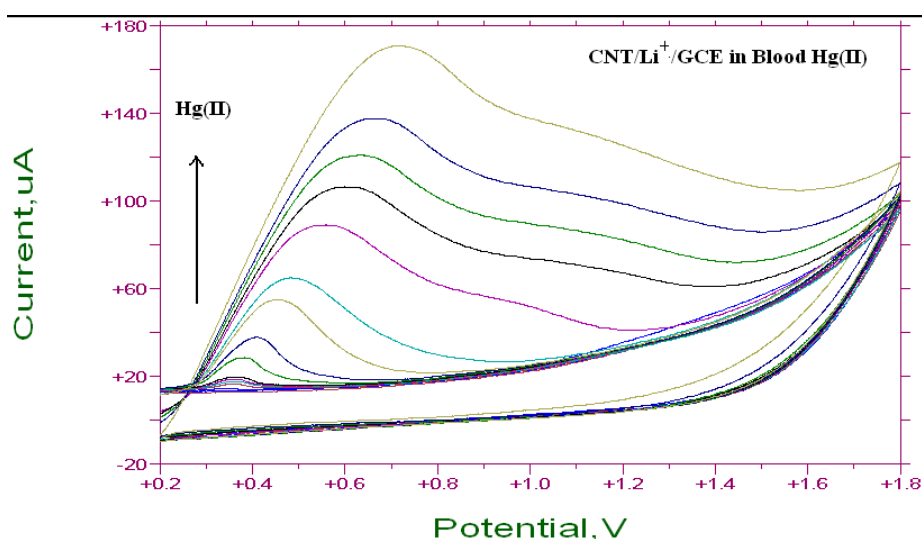


Fig. 6. Voltammograms for the oxidation current at modified CNT/ Li^+ /GCE in different concentrations of (0.1-10 mM) Hg(II) with blood sample as supporting electrolyte versus Ag/AgCl as reference electrode and scan rate 100 mV sec^{-1} .

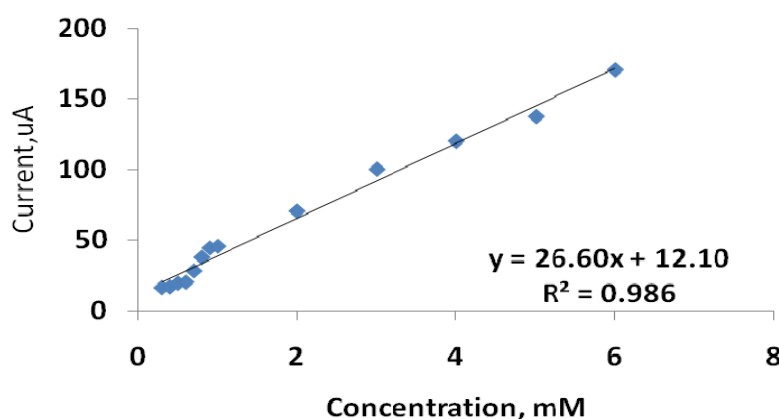


Fig. 7. Plot oxidation current of different concentrations (0.3-6 mM) of Hg(II) in blood sample using CNT/ Li^+ /GCE as working electrode and scan rate 100 mV sec^{-1} .

The $\text{C}_{60}/\text{Li}^+$ /GCE was applied for successive determination of redox peaks of Hg(II) in blood sample at different concentrations as shown in Fig. 8. The correlation coefficient of calibration plots for

oxidation peak of Hg(II) at different concentration ranges 3×10^{-3} - 6×10^{-2} M was investigated with good linearity, sensitivity and good RDS ($R^2 = 0.978$, $Y = 12.02x + 6.919$ and $RSD = \pm 3.1\%$) as shown in Fig. 9.

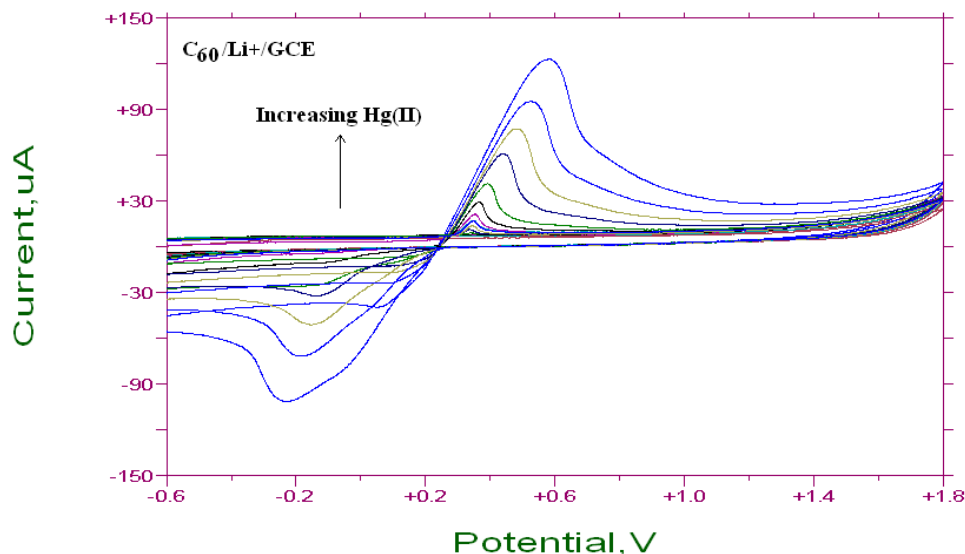


Fig. 8. Voltammograms for the oxidation current at modified $C_{60}/Li^+/GCE$ in different concentrations of (1-10 mM) of Hg(II) with blood sample as supporting electrolyte versus Ag/AgCl as reference electrode and scan rate 100 mV sec^{-1} .

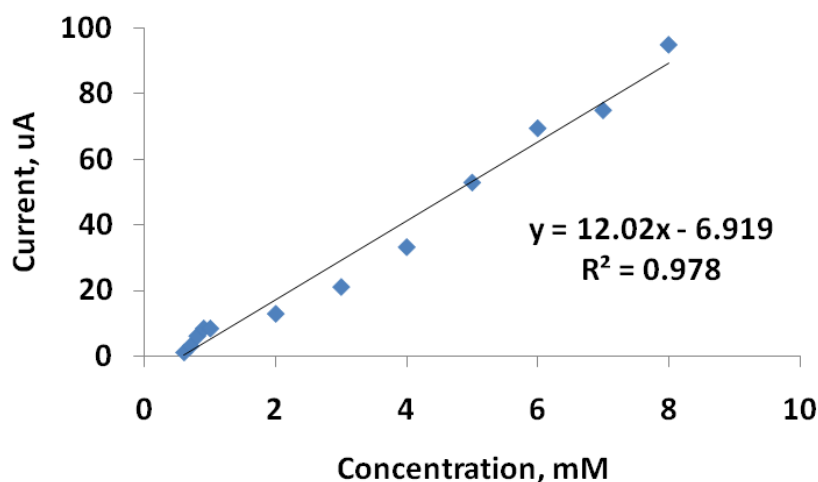


Fig. 9. Plot oxidation current of different concentrations (0.6-8 mM) of Hg(II) in blood sample using $C_{60}/Li^+/GCE$ as working electrode and scan rate 100 mV sec^{-1} .

The AC/GCE exhibited a good performance for Hg(II) analysis as shown in Fig. 10. A well-defined curve was observed at +400 mV corresponding to the oxidation peak of Hg(II) in blood sample. The calibration plots were performed on the CNT/Li⁺/GCE within the concentration range of 5×10^{-3} - 8×10^{-2} M for the Hg(II) in blood sample as shown in Fig. 11 with a correlation coefficient of $R^2=0.992$, $Y=19.61x+33.19$ and good results of $RSD \pm 3.5\%$.

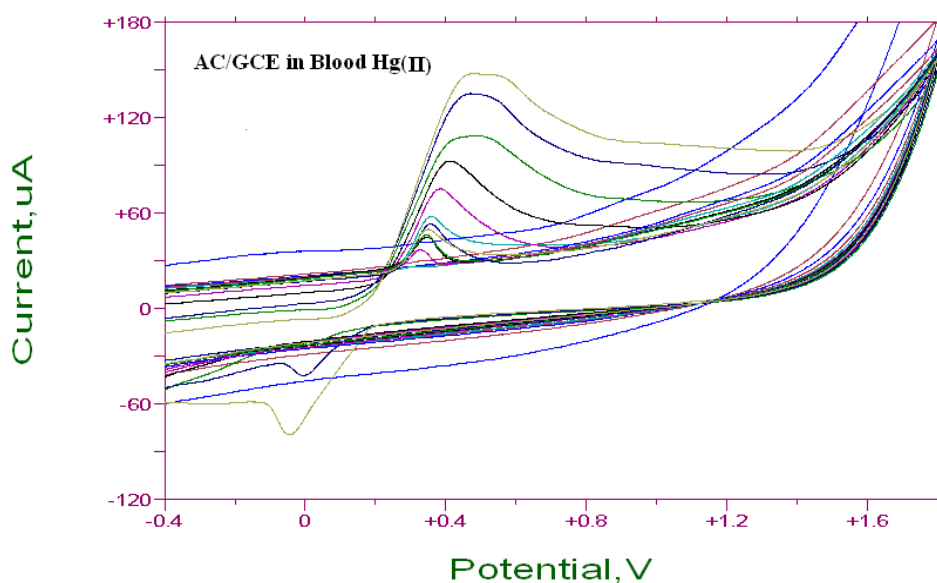


Fig. 10. Voltammograms for the oxidation current at modified AC/GCE in different concentrations of (0.1-10 mM) of Hg(II) with blood sample as supporting electrolyte versus Ag/AgCl as reference electrode and scan rate 100 mV sec^{-1} .

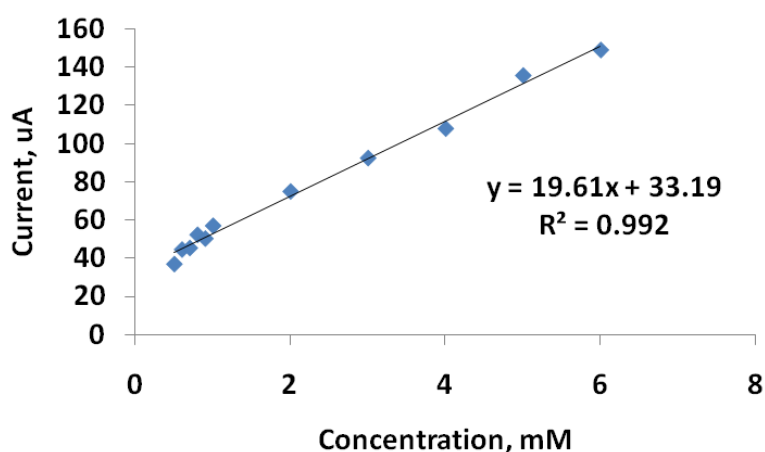


Fig. 11. Plot oxidation current of different concentrations (0.5-8 mM) of Hg(II) in blood sample using AC/GCE as working electrode and scan rate 100 mVsec^{-1} .

The developed method was applied for the detection of Hg(II) in blood medium in order to evaluate the applicability of CNT/Li⁺/GCE, C₆₀/Li⁺/GCE and AC/GCE modified electrodes in real sample application. The results were summarized in Table 1 with good sensitivity and detection limit.

Table 1. Different parameters for different modified electrodes used as sensors of Hg(II) in blood medium.

Modified electrodes	Detection limit (Molar)	Sensitivity, R ²	Correlation coefficient	Relative standard deviation, RSD
CNT/Li ⁺ /GCE	3×10^{-3} - 6×10^{-2}	0.986	$Y=26.60x+12.10$	$\pm 2.4 \%$
C ₆₀ /Li ⁺ /GCE	6×10^{-3} - 8×10^{-2}	0.978	$Y=12.02x+6.919$	$\pm 3.1 \%$
AC/GCE	5×10^{-3} - 8×10^{-2}	0.992	$Y=19.61x+33.19$	$\pm 3.5 \%$

3.3. Reproducibility Study of CNT/Li⁺ Doped Modified GCE

It was found that based on four replicates, the oxidation current of Hg(II) resulted in a relative standard deviation (RSD) with a value of 2.4 %. Since it is less than 3 %, it shows that the Li⁺ doped CNT/GCE is also characterized by good reproducibility.

4. Conclusion

The lithium doped modified CNT/GCE, C₆₀/GCE and only AC/GCE were proven to be sensitive electrodes for the detection of Hg(II) ions. The presence of lithium doped modified CNT/GCE causes enhancement of the oxidation current of Hg(II) ion by about three times if compared with other electrodes. The sensitivity of current enhancement was strongly dependent on the concentration of Hg(II) ion in blood media. The sensitivity, expressed as the slope of the linear region of the calibration curve was 26.6 $\mu\text{A}/\text{mM}$ with a correlation coefficient of 0.986. The detection limit of $3 \times 10^{-3} \text{M}$ was determined. For the future work, the capability of the CNT/Li⁺/GCE, C₆₀/Li⁺/GCE and AC/GCE composite modified electrodes to detect some biological and environmental compounds will be investigated using voltammetric techniques.

Acknowledgments

The authors wish to thank the University of Putra Malaysia for providing research facilities and support for the fulfillment of this work.

References

- [1]. W. Yantasee, Y. Lin, K. Hongsirikarn, G. E. Fryxell, R. Addleman, and C. Timchalk, Electrochemical Sensors for the Detection of Lead and Other Toxic Heavy Metals: The Next Generation of Personal Exposure Biomonitoring, *Environmental Health Perspectives*, 115, 2007, pp. 1683–1690.
- [2]. J. R. Stetter, W. R. Penrose and S. Yao, Sensors, Chemical Sensors, Electrochemical Sensors, and ECS, *J. Electrochemical Society*, 150, 2003, pp. 11-16.
- [3]. A. M. Donoghue, Occupational health hazards in mining, *Occupational Medicine*, 54, 2004, pp. 283–289.
- [4]. F. Zahir, S. J. Rizwi, S. K. Haqb and R. H. Khanb, Low dose mercury toxicity and human health, *Environmental Toxicology and Pharmacology*, 20, 2005, pp. 351–360.
- [5]. Y. Wang, H. Xu, J. Zhang and G. Li, Electrochemical Sensors for Clinic Analysis, *Sensors*, 2008, 8, pp. 2043-2081.
- [6]. C. Liu, Electrochemical Sensors, 2nd Edition. Ed. Joseph D. Bronzino, *CRC Press LLC*, Boca Raton, 2000.
- [7]. N. Y. Stozhko, N. A. Malakhova, M. V. Fyodorov and K. Z. Brainina, Modified carbon-containing electrodes in stripping voltammetry of metals, *J. Solid State Electrochem*, 12, 2008, pp. 1185–1204.
- [8]. T. Hezarda, K. Fajerwerge, V. Collièree, D. Evrarda, P. Behrab and P. Grosa, Gold nanoparticles electrodeposited on glassy carbon using cyclic voltammetry: Application to Hg(II) trace analysis, *J. Electroanalytical Chemistry*, 664, 2012, pp. 46–52.
- [9]. M. Heitzmann, L. Basaez, F. Brovelli, C. Bucher, D. Limosin, E. Pereira, B. Rivas, G. Royal, E. Saint and J. C. Moutet, Voltammetric Sensing of Trace Metals at a Poly(pyrrole-malonic acid) Film Modified Carbon Electrode, *Electroanalysis*, 17, 2005, pp. 1970–1976.
- [10] A. J. Ahammad, J. Lee and M. A. Rahman, Electrochemical Sensors Based on Carbon Nanotubes, *Sensors*, 9, 2009, pp. 2289-2319.
- [11]. G. Perenlei, T. W. Tee, N. A. Yusof, G. J. Kheng, Voltammetric Detection of Potassium Ferricyanide Mediated by Multi-walled Carbon Nanotube/Titanium Dioxide Composite Modified Glassy Carbon Electrode, *Int. J. Electrochem. Sci.*, 6, 2011, pp. 520 - 531.
- [12]. W. Yantasee, B. Charnhattakorn, G. E. Fryxell, Y. Lin, C. Timchalk, and R. S. Addleman, Detection of Cd, Pb, and Cu in Non-Pretreated Natural Waters and Urine with Thiol Functionalized Mesoporous Silica and Nafion

Composite Electrodes, *Anal. Chim. Acta*, 2008, 620, pp. 55–63.

- [13].H. Xu, L. Zeng, S. Xing, G. Shi, Y. Xian and L. Jin, Microwave-radiated synthesis of gold nanoparticles/carbon nanotubes composites and its application to voltammetric detection of trace mercury(II). *Electrochem. Comm.*, 10, 2008, pp. 1839-1843.
- [14].Instruction manual, CV 50W, version 2, *Bioanalytical System, Inc.*, USA, 1996.
- [15].F. Scholz and B. Lange, Abrasive stripping voltammetry - an electrochemical solid state spectroscopy of wide applicability, *Trends in Analytical Chemistry*, 11, 1992, pp. 359-367.
- [16].W. T. Tan, G. K. Ng and A. M. Bond, Electrochemical of microcrystalline tetrathiafulvalene at an electrode solid aqueous KBr interface, *Malaysian J. Chem.* 2, 2000, pp. 34-42.
- [17].W. T. Tan, E. Lim and A. Bond, Voltammetric studies on microcrystalline C60 adhered to an electrode surface by solvent casting and mechanical transfer methods, *J. Solid State Electrochem.*, 7, 2003, pp. 134-140.

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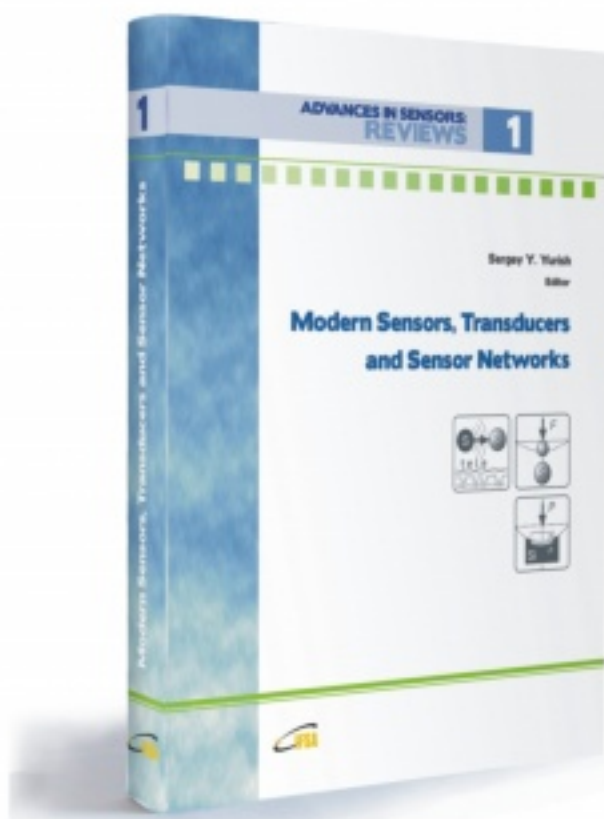
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