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| PhD    | Pınar Sari Çavdar     | İzmir Demokrasi University                      |
### Oral Presentation

**07 November 2019 - Thursday**

**Opening Speech**

| Time       | Company                                      | Speaker                                              |
|------------|----------------------------------------------|------------------------------------------------------|
| 10:00 - 10:15 | TURKISH AIRCRAFT INDUSTRIES CORPORATION (TUSAŞ) | Scientific and Technological Collaboration Chief - PhD. Onur Jane |
| 10:15 - 10:30 | SANKO HOLDING                                | Research and Development Unit Chief - Seval Ayata Konukoğlu |

#### Session 1

**Hall Name:** Meeting Hall 1  
**Meeting Hall Chairman:** PhD. İlhan Çelik  
**Meeting Hall Vice-Chairman:** Sinem Gülşen

| Time       | Title of Study                                                                 | Authors                                   | Corresponding Author | Presenter |
|------------|--------------------------------------------------------------------------------|-------------------------------------------|----------------------|-----------|
| 10:30 - 10:45 | ROLE AND IMPORTANCE OF TTOS IN TECHNOLOGY TRANSFER                           | İlhan Çelik                               | İlhan Çelik          | İlhan Çelik |
| 10:45 - 11:00 | EFFECT OF THIN METAL BAR REINFORCEMENT ON JOINT DAMAGE LOAD IN ADHESIVELY BONDED JOINTS | Kübra Demir, Salih Akpınar               | Salih Akpınar        | Salih Akpınar |
| 11:00 - 11:15 | INVESTIGATION OF IMPACT RESISTANCE OF CESTAMIDE MATERIAL BELOW PURE WATER AND EXCESS SALT WATER | Cüneyd Demir, Mustafa Bozdemir           | Cüneyd Demir         | Mustafa Bozdemir |
| 11:15 - 11:30 | SOLAR HYDROGEN PRODUCTION WITH COPPER-LANTHANIDE CO-DOPED TiO2 PHOTOCATALYSTS | Hüsnü Arda Yurtsever, Muhsin Çifçiçoğlu   | Hüsnü Arda Yurtsever | Hüsnü Arda Yurtsever |
| 11:30 - 11:45 | ENVIRONMENTAL AND ECONOMIC COMPARISONS OF COAL AND NATURAL GAS POWER PLANTS WITH RETSCREEN PROGRAM | Tuğba Güler Günyaydın Tanç, Hüseyin Turan Arat, Bahattin Tanç | Hüseyin Turan Arat   | Bahattin Tanç |
| 11:45 - 12:00 | INVESTIGATION OF IONOSPHERIC VARIATION CAUSED BY MODERATE MAGNETIC STORM USING GNSS MEASUREMENTS | Samed İnyurt                              | Samed İnyurt         | Samed İnyurt |

#### Session 2 - Invited Speakers

**Hall Name:** Meeting Hall 2  
**Meeting Hall Chairman:** PhD. Uğur Çavdar  
**Meeting Hall Vice-Chairman:** Lect. Umut Saray

| Time       | Title of Study                                                                 | Authors                                   | Corresponding Author | Country |
|------------|--------------------------------------------------------------------------------|-------------------------------------------|----------------------|---------|
| 10:30 - 10:45 | FUTURE RENEWABLE ENERGY INTEGRATION AND IOT APPLICATIONS IN SMART GRIDS        | Abdurrahman Shuaibu Hassan, Yanxia Sun, Zhenghui Wang | Abdurrahman Shuaibu Hassan | South Africa |
| 10:45 - 11:00 | ON FARM VALIDATION OF AGRICULTURAL INNOVATIONS FOR SUPPORTING DURUM WHEAT EXTENSION PACKAGE FORMULATION IN ETHIOPIA | Aklilu Nigussie, Abdu Mohammed, Wafiu Legese, Rehima Musema | Aklilu Nigussie | Ethiopia |
| 11:00 - 11:15 | HYDROTHERMAL ALTERATION ASSEMBLAGES AROUND DUTSEN DANBAKOSHI, NORTHWESTERN NIGERIA; INSIGHTS FROM MULTI-FRACTAL ANALYSIS OF MEASURED_THRESHOLDS FOR MINERAL EXPLORATION. | Amuda, A.K, Andongma, W.T., S Alaa S.L, Gajere, J.N., Agunleti, Y.S | Amuda, A.K | Nigeria |
| 11:15 - 11:30 | VISCOSITY IS AN INDISPENSABLE TOOL TO DETERMINE STANDARD LUBRICANTS     | Atiku F. A, Sani M. B, Afida ZISIG, Yusuf A.A, Abdulrahman H.S, Sharif | Atiku F. A | Uganda |
| Time       | Title of Study                                                                 | Authors                     | Corresponding Author | Presenter         |
|------------|--------------------------------------------------------------------------------|-----------------------------|-----------------------|-------------------|
| 11:30 - 11:45 | ON THE USE OF EMOTIONAL ARTIFICIAL NEURAL NETWORK (EANN) AND CLASSIFICATION AND REGRESSION TREE TECHNIQUE (CART) MODELS FOR ESTIMATING OF MINIMUM AND MAXIMUM AIR TEMPERATURE IN SELECTED SEMI-ARID STATIONS OF IRAN | Nasrin Fatollahzadeh Attar, Keivan Khalili, Javad Behmanesh | Keivan Khalili | Iran             |
| 11:45 - 12:00 | SELECTION OF SUPPLIERS WITH FUZZIES AHP METHOD: APPLICATION ON A TEXTILE CHEMICALS FACTORY IN GAZIANTEP | Pelin Kansıslı, Aminu Muhammad Fagge | Pelin Kansıslı | Turkey |

**Session 3**

**Hall Name:** Meeting Hall 5

**Meeting Hall Chairman:** Lect. Tolga Yücehan

**Meeting Hall Vice-Chairman:** Lect. Celal Altıntaş

| Time       | Title of Study                                                                 | Authors                     | Corresponding Author | Presenter         |
|------------|--------------------------------------------------------------------------------|-----------------------------|-----------------------|-------------------|
| 10:30 - 10:45 | THE BENDING ELASTICITY MODULE OF WOOD LAMINATED MATERIALS REINFORCED WITH GLASS FIBER POLYMER | Abdurrahman Karaman, Mehmet Nuri Yıldırım | Abdurrahman Karaman | Mehmet Nuri Yıldırım |
| 10:45 - 11:00 | GELENEKSEL SAFRANBOLU TARİHİ KONAKLARIN YEŞİL BİNA KAPSAMINDA ARĂŞTIRILMASINDA ULUSLARARASI LEED DEGERLENDIRME SİSTEMİN KULLANILMASI: KARABUK SAFRANBOLU KAYMAKALMAR KONAGI ORNEĞI | Mehmet Nuri Yıldırım, Abdurrahman Karaman, Mehmet Aygün | Abdurrahman Karaman | Mehmet Nuri Yıldırım |
| 11:00 - 11:15 | MODELING OF TRIANGLE WAVE GENERATING OSCILLATOR CIRCUITS WITH ARTIFICIAL NEURAL NETWORKS | Remzi Tuntaş | Remzi Tuntaş | Remzi Tuntaş |
| 11:15 - 11:30 | ESTIMATING OF TRANSFER FUNCTION MODELS WITH ARTIFICIAL NEURAL NETWORKS FOR A BOOST CONVERTER CIRCUIT | Remzi Tuntaş | Remzi Tuntaş | Remzi Tuntaş |
| 11:30 - 11:45 | DESIGN OF AN INTEGRATOR CIRCUIT WITH ANFIS BASED MODELING TECHNIQUE | Remzi Tuntaş | Remzi Tuntaş | Remzi Tuntaş |
| 11:45 - 12:00 | MANAGEMENT OF RAIN WATER IN CAMPUS | Can Hançer, İlter Türkdoğan | Can Hançer | Can Hançer |

**Session 4**

**Hall Name:** Meeting Hall 1

**Meeting Hall Chairman:** PhD. Pınar Sarı Çavdar

**Meeting Hall Vice-Chairman:** Lect. Erdem Kanışlı

| Time       | Title of Study                                                                 | Authors                     | Corresponding Author | Presenter         |
|------------|--------------------------------------------------------------------------------|-----------------------------|-----------------------|-------------------|
| 13:00 - 13:15 | AUTONOMOUS MODEL AIRPLANE SUPPORTED BY SOLAR CELLS | Cüneyd Demir | Cüneyd Demir | Cüneyd Demir |
| 13:15 - 13:30 | COST STUDY OF MICROGRID APPLICATION IN TURKEY | Mehmet Emrah Şeker, Ahmet Karaarslan | Mehmet Emrah Şeker | Mehmet Emrah Şeker |
| 13:30 - 13:45 | DIODE PRODUCTION BY EVAPORATING SILVER WITH COLD SUBSTRATE METHOD ON ZINC OXIDE THIN FILMS AND CHARACTERIZATION | Melih Manır, Muhammet Mando, Vagif Nevruzoğlu | Melih Manır | Melih Manır |
| 13:45 - 14:00 | EVALUATION OF MARINE ACCIDENTS INVOLVING BULK CARRIER AND GENERAL CARGO VESSELS | Ahmet Lutfi Tunçel, Vahit Çalışr, Ercan Yüksekylıdır | Ahmet Lutfi Tunçel | Ahmet Lutfi Tunçel |
| 14:00 - 14:15 | ASSESSMENT OF ENERGY EFFICIENCY OF A BULK CARRIER SHIP IN ACCORDANCE WITH INTERNATIONAL REGULATIONS | Berna Kanberoğlu, Görkem Kökçülink | Berna Kanberoğlu | Berna Kanberoğlu |

**Session 5 - Invited Speakers**

**Hall Name:** Meeting Hall 2

**Meeting Hall Chairman:** Ph.D. Uğur Çavdar

**Meeting Hall Vice-Chairman:** Lect. Umut Saray
| Time       | Title of Study                                                                 | Authors                                                                                     | Corresponding Author | Presenter  |
|------------|---------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------|----------------------|------------|
| 13:00 - 13:15 | ARTIFICIAL INTELLIGENCE IN THE MANAGEMENT OF CYBERSECURITY BENEFITS, CHALLENGES, AND PROSPECT IN A DEVELOPING ECONOMY, AFRICA | Yakubu Ajiji Makeri, Chinecherem Umezuruike, Habiba Njeri Ngugi, Abdurrahman Shuaibu Hassan | Yakubu Ajiji Makeri | Uganda     |
| 13:15 - 13:30 | ULTRASONICATION AS AN EMERGING TECHNIQUE FOR THE FOOD INDUSTRIES                | Rana Muhammad Aadil                                                                       | Rana Muhammad Aadil   | Pakistan   |
| 13:30 - 13:45 | NUMERICAL SIMULATION OF CAVITATION PHENOMENON ON Ogee Spillway                  | Rasoul Daneshfaraz, Reza Norouzi                                                        | Rasoul Daneshfaraz   | Iran       |
| 13:45 - 14:00 | REGULATING CARBON FOOTPRINT THROUGH CLEAN DEVELOPMENT MECHANISM                 | Ronald Sanya, Tajudeen Sanni, Abubakar Atiku                                               | Ronald Sanya          | Uganda     |

**Session 6**

| Time       | Title of Study                                                                 | Authors                                                                                     | Corresponding Author | Presenter  |
|------------|---------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------|----------------------|------------|
| 13:00 - 13:15 | SIMULATION OF OPTIMAL ROBOT PATH PLANNING WITH RANDOM INERTIA WEIGHTED PARTICLE SWARM OPTIMIZATION | Mehmet Fatih Tefek                                                                        | Mehmet Fatih Tefek   | Mehmet Fatih Tefek |
| 13:15 - 13:30 | YAPI SINIR AGLARI KULLANARAK BINA ICWI WIFI SINYALLERLE KONUM BULMA               | Umran Şeker, Abdullah Erdal Tuner                                                           | Umran Şeker          | Abdullah Erdal Tuner |
| 13:30 - 13:45 | FFPA BASED DESIGN AND IMPLEMENTATION OF SPROTT N CHAOTIC SYSTEM                  | Serdar Çiçek                                                                               | Serdar Çiçek          | Serdar Çiçek |
| 13:45 - 14:00 | GEOTEXTILES AND USAGE AREAS                                                      | Asım Davulcu, Şerife Erdoğan, Utkay Dönmez, Hatay Çiçek                                     | Asım Davulcu         | Asım Davulcu |
| 14:00 - 14:15 | INVESTIGATION THE EFFECT OF SOFTENERS ON VAPOR PERMEABILITY OF WOOL FABRICS     | Asım Davulcu, Tümay Yulet Nur                                                              | Asım Davulcu         | Asım Davulcu |

**Coffee Break**

**Session 7**

| Time       | Title of Study                                                                 | Authors                                                                                     | Corresponding Author | Presenter  |
|------------|---------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------|----------------------|------------|
| 14:30 - 14:45 | ELECTROCHEMICAL PROPERTIES, MECHANICAL AND TRIBOLOGICAL BEHAVIORS OF COPPER-CHROMIUM-ZIRCONIUM ALLOYS | İlhan Çelik                                                                               | İlhan Çelik          | İlhan Çelik |
| 14:45 - 15:00 | EFFECTS OF DIFFERENT SURFACE MODIFICATION METHODS ON MECHANICAL AND TRIBOLOGICAL PROPERTIES OF Ti-6Al-V ALLOY | İlhan Çelik                                                                               | İlhan Çelik          | İlhan Çelik |
| 15:00 - 15:15 | THE EFFECT OF FIBER REINFORCED COMPOSITE ADHESIVE ON FAILURE LOAD IN SINGLE-LAP JOINT | Kübra Demir, Esma Gavgalı, Salih Akpinar                                                  | Salih Akpinar        | Salih Akpinar |
| 15:15 - 15:30 | MECANUM WHEEL DESIGN AND MANUFACTURE FOR A MODEL UGV                             | Cüneyd Demir                                                                              | Cüneyd Demir         | Cüneyd Demir |
| 15:30 - 15:45 | INVESTIGATING SPRINGBACK BEHAVIOR OF ALUMINUM ALLOY SHEET METAL BY USING ALTERNATIVE TESTING METHOD | Elif Malyer                                                                               | Elif Malyer          | Elif Malyer |
## Session 8

| Time       | Title of Study                                                                 | Authors                          | Corresponding Author | Presenter       |
|------------|--------------------------------------------------------------------------------|----------------------------------|----------------------|-----------------|
| 14:30 - 14:45 | EVALUATION OF BIOCHAR APPLICATIONS IN THE SOIL IN TERMS OF CARBON SEQUESTRATION | Ahmet Duyar, Yasin Dönmez        | Ahmet Duyar          | Yasin Dönmez    |
| 14:45 - 15:00 | FOREST FIRE PROTECTION MEASURES IN BARTIN REGION                               | Mertol Ertuğrul, Tuğrul Varol   | Mertol Ertuğrul      | Mertol Ertuğrul |
| 15:00 - 15:15 | FOREST FIRE IN KARABAŞ CHANGES OVER THE YEARS                                 | Mertol Ertuğrul                  | Mertol Ertuğrul      | Mertol Ertuğrul |
| 15:15 - 15:30 | SOIL INDEX PROPERTIES AND BEARING CAPACITY OF SOIL ON FOREST ROADS             | Tuğrul Varol, Mertol Ertuğrul   | Tuğrul Varol         | Tuğrul Varol    |
| 15:30 - 15:45 | THE CONCEPT OF URBAN URBANITY AND SAFRANBOLU URBAN FOREST INVESTIGATION OF RECREATIONAL OPPORTUNITIES | Yasin Dönmez, Ahmet Duyar        | Yasin Dönmez          | Ahmet Duyar     |

Coffee Break

## Session 9

| Time       | Title of Study                                                                 | Authors                          | Corresponding Author | Presenter       |
|------------|--------------------------------------------------------------------------------|----------------------------------|----------------------|-----------------|
| 16:00 - 16:15 | AN APPLICATION OF RESPONSE SURFACE METHODOLOGY ON OPTIMIZATION OF A (Q,S) INVENTORY SYSTEM | Esra Ekinci, Semra Tunali        | Esra Ekinci          | Esra Ekinci     |
| 16:15 - 16:30 | ÖĞRENME ETKISI ALTINDA İŞ REDDETMELI TEK MAKINE ÇIZELGELEME PROBLEMLERİNDE MAKSİMUM TAMAMLAMA ZAMANI EN KUÇUKLENMESİ | Berrin Atalay, M. Duran Tiksari | M. Duran Tiksari    | Berrin Atalay   |
| 16:30 - 16:45 | AIRJET İPLİK MAKİNELERİ ÜRETİM DEĞİŞKENLERİ OPTİMİZASYONU VE İPLİK KALİTESİ ÜZERİNDEKI ETKİSİ: GAZİANTEP ÖRNEĞİ | Cansu Batçık, Mevhibe Oya Çetik | Mevhibe Oya Çetik   | Cansu Batçık    |
| 16:45 - 17:00 | MODELING AND SOLVING MULTIPLE VEHICLE TRAVELING PURCHASER PROBLEM WITH CAPACITY CONSTRAINT | Selin Çabuk                        | Selin Çabuk          | Selin Çabuk     |
| 17:00 - 17:15 | ÖĞRENME ETKISI ALTINDA İŞ REDDETMELI TEK MAKINE ÇIZELGELEME PROBLEMLERİNDE TOPLAM TAMAMLANMA ZAMANI EN KUÇUKLENMESİ | Berrin Atalay, M. Duran Tiksari | M. Duran Tiksari    | Berrin Atalay   |
| 17:15 - 17:30 | EVALUATION OF WATER QUALITY IN THE DOĞANCI DAM RESERVOIR BY PCA                | Feza Karaer, Ayşe Kurt           | Feza Karaer          | Feza Karaer     |
| 17:30 - 17:45 | IMPROVEMENT OF CONDUCTIVE TEXTILE SURFACES AND IMPROVEMENT OF PHYSICAL PERFORMANCE | Erhan Sancak, Seval Ayata Komukoğlu | Seval Ayata Komukoğlu | Seval Ayata Komukoğlu |

## Session 10

| Time       | Title of Study                                                                 | Authors                          | Corresponding Author | Presenter       |
|------------|--------------------------------------------------------------------------------|----------------------------------|----------------------|-----------------|
| 16:00 - 16:15 | A RESEARCH ON POSSIBILITIES OF BORON USE IN FOOD INDUSTRY                        | Bekir Güney, Süleyman Gökmen     | Bekir Güney          | Süleyman Gökmen |
| 16:15 - 16:30 | DIETARY SUPPLEMENT: ISSUE OF SAFETY AND                                         | Gülşin Yıldız, Gülşen Bayat,     | Gülşin Yıldız         | Gülşin Yıldız    |
| Time         | Title of Study                                                                 | Authors                     | Corresponding Author | Presenter  |
|--------------|--------------------------------------------------------------------------------|-----------------------------|----------------------|------------|
| 16:30 - 16:45 | ANTIOXIDANT CAPACITY AND TOTAL PHENOLIC CONTENT OF PEPINO SLICES DRIED WITH DIFFERENT METHODS | Gülçin Yıldız, Şenel Ecem Berk, Gökçen İzli | Gülçen İzli          | Gülçin Yıldız |
| 16:45 - 17:00 | ASSEMBLY LINE BALANCING IN A TRACTOR PRODUCING COMPANY WITH RANKED POSITIONAL WEIGHTED METHOD AND COMSOAL METHOD | Seher Arslankaya            | Seher Arslankaya     | Seher Arslankaya |
| 17:00 - 17:15 | IMPROVEMENT OF MOLD CHANGE TIMES WITH SMED METHODOLOGY IN AN ALUMINUM MANUFACTURING COMPANY | Seher Arslankaya            | Seher Arslankaya     | Seher Arslankaya |
| 17:15 - 17:30 | DEMAND FORECASTING WITH MULTIPLE REGRESSION ANALYSIS AND ARTIFICIAL NEURAL NETWORKS IN A TIRE FACTORY | Seher Arslankaya            | Seher Arslankaya     | Seher Arslankaya |
| 17:30 - 17:45 | MODELLING PREVENTIVE MAINTENANCE POLICY FOR DISASSEMBLY LINES | Ömer Faruk Yılmaz           | Ömer Faruk Yılmaz    | Ömer Faruk Yılmaz |
| 17:45 - 18:00 | DISASSEMBLY LINE BALANCING PROBLEM: A REVIEW ABOUT INDUSTRY 60 | Seda Hezer, Yakup Kara      | Seda Hezer           | Seda Hezer  |
| 18:00 - 18:15 | CLASSIFICATION OF MORPHOLOGICAL IRIS PROPERTIES USING NAIVE BAYES CLASSIFIER | Emre Avuçlu, Abdullah Elen  | Abdullah Elen        | Abdullah Elen |
| 10:30 - 10:45 | ENSILING POSSIBILITIES OF SOME PLANT SPECIES IN UŞAK PROVINCE NATURAL VEGETATION | Asuman Arslan Duru, İbrahim Bulduk, Ercüment Osman Sarihan | Asuman Arslan Duru | Asuman Arslan Duru |
| 10:45 - 11:00 | INVESTIGATION OF IMMOBILIZATION PROCESS OF SCREEN PRINTED CARBON ELECTRODE FOR AN ADVANCED BIOSENSOR: A DETAILED CHARACTERIZATION | Yücel Koç, Uğur Morali, Salim Erol, Hüseyin Avcı | Huseyin Avcı       | Yücel Koç    |
| 11:00 - 11:15 | BIOACTIVE GLASS COATINGS VIA SOL-GEL METHOD | Lale Civan, Macid Nurbaş | Lale Civan           | Lale Civan  |
| 11:15 - 11:30 | GELATION BEHAVIOUR AND BIOCOMPATIBILITY OF TiO2 AND CeO2 INCORPORATED CHITOSAN SOLUTIONS | Merve Çapkin Yurtsever | Merve Çapkin Yurtsever | Merve Çapkin Yurtsever |
| 11:30 - 11:45 | SYNTHESIS AND CHARACTERIZATION OF MAGNETIC ACTIVATED CARBON USING ACTIVATED CARBON PREPARED FROM BINARY MIXTURE | Ramazan Orhan, Hasan Arslanoğlu | Ramazan Orhan       | Ramazan Orhan |
| 11:45 - 12:00 | REMOVAL OF ACID BROWN 349 DYES BY FENTON OXIDATION METHOD | Tüba Berberoğlu, Macid Nurbaş | Tüba Berberoğlu     | Macid Nurbaş |
| 10:30 - 10:45 | PROPERTIES OF AIRCRAFT BRAKING SYSTEMS | Bekir Güney | Bekir Güney        | Bekir Güney |
| 10:45 - 11:00 | WORK STUDY AND SIMULATION FOR CAPACITY INCREASING IN AN AUTOMOTIVE COMPANY | Tülay Korkusuz Polat, Betül Palabiyokerglu | Tülay Korkusuz Polat | Tülay Korkusuz Polat |
| 11:00 - 11:15 | PROCESS IMPROVEMENT IN A TRACTOR COMPANY | Tülay Korkusuz Polat, Büşra Güngör | Tülay Korkusuz Polat | Tülay Korkusuz Polat |
| 11:15 - 11:30 | YAPAY ARI KOLONI ALGORITMASININ KAPASITE KISITLI ARAC ROTALAMA PROBLEMLERİNDEKİ SONUÇLARININ YAPAY SINIR AGI İLE TAHMIN EDİLMESİ | Dursun Ekmekeci, Abdullah Elen | Abdullah Elen       | Abdullah Elen |

08 November 2019 - Friday

Session 11

Hall Name: Meeting Hall 1

Meeting Hall Chairman: Ph.D. Asuman Arslan Duru
Meeting Hall Vice-Chairman: Lect. Umut Saray

| Time         | Title of Study                                                                 | Authors                     | Corresponding Author | Presenter  |
|--------------|--------------------------------------------------------------------------------|-----------------------------|----------------------|------------|
| 10:30 - 10:45 | ENSILING POSSIBILITIES OF SOME PLANT SPECIES IN UŞAK PROVINCE NATURAL VEGETATION | Asuman Arslan Duru, İbrahim Bulduk, Ercüment Osman Sarihan | Asuman Arslan Duru | Asuman Arslan Duru |
| 10:45 - 11:00 | INVESTIGATION OF IMMOBILIZATION PROCESS OF SCREEN PRINTED CARBON ELECTRODE FOR AN ADVANCED BIOSENSOR: A DETAILED CHARACTERIZATION | Yücel Koç, Uğur Morali, Salim Erol, Hüseyin Avcı | Huseyin Avcı       | Yücel Koç    |
| 11:00 - 11:15 | BIOACTIVE GLASS COATINGS VIA SOL-GEL METHOD | Lale Civan, Macid Nurbaş | Lale Civan           | Lale Civan  |
| 11:15 - 11:30 | GELATION BEHAVIOUR AND BIOCOMPATIBILITY OF TiO2 AND CeO2 INCORPORATED CHITOSAN SOLUTIONS | Merve Çapkin Yurtsever | Merve Çapkin Yurtsever | Merve Çapkin Yurtsever |
| 11:30 - 11:45 | SYNTHESIS AND CHARACTERIZATION OF MAGNETIC ACTIVATED CARBON USING ACTIVATED CARBON PREPARED FROM BINARY MIXTURE | Ramazan Orhan, Hasan Arslanoğlu | Ramazan Orhan       | Ramazan Orhan |
| 11:45 - 12:00 | REMOVAL OF ACID BROWN 349 DYES BY FENTON OXIDATION METHOD | Tüba Berberoğlu, Macid Nurbaş | Tüba Berberoğlu     | Macid Nurbaş |

Session 12

Hall Name: Meeting Hall 5

Meeting Hall Chairman: Lect. Tolga Yücehan
Meeting Hall Vice-Chairman: Lect. Celal Altıntaş

| Time         | Title of Study                                                                 | Authors                     | Corresponding Author | Presenter  |
|--------------|--------------------------------------------------------------------------------|-----------------------------|----------------------|------------|
| 10:30 - 10:45 | PROPERTIES OF AIRCRAFT BRAKING SYSTEMS | Bekir Güney | Bekir Güney        | Bekir Güney |
| 10:45 - 11:00 | WORK STUDY AND SIMULATION FOR CAPACITY INCREASING IN AN AUTOMOTIVE COMPANY | Tülay Korkusuz Polat, Betül Palabiyokerglu | Tülay Korkusuz Polat | Tülay Korkusuz Polat |
| 11:00 - 11:15 | PROCESS IMPROVEMENT IN A TRACTOR COMPANY | Tülay Korkusuz Polat, Büşra Güngör | Tülay Korkusuz Polat | Tülay Korkusuz Polat |
| 11:15 - 11:30 | YAPAY ARI KOLONI ALGORITMASININ KAPASITE KISITLI ARAC ROTALAMA PROBLEMLERİNDEKİ SONUÇLARININ YAPAY SINIR AGI İLE TAHMIN EDİLMESİ | Dursun Ekmekeci, Abdullah Elen | Abdullah Elen       | Abdullah Elen |
INVESTIGATION OF IMMOBILIZATION PROCESS OF SCREEN PRINTED CARBON ELECTRODE FOR AN ADVANCED BIOSENSOR: A DETAILED CHARACTERIZATION

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Abstract

Recently, electrochemical methods are of growing interest. Electrochemical methods used in the development of sensors have many advantages such as high sensitivity, short response time, and low cost. Screen-printed electrodes (SPEs) are one of the electrochemical devices utilized as sensors that are used in a wide range of applications from health to food. In this study, the surface functionalization of commercially available screen-printed carbon electrodes (SPCE) were carried out, and the layers formed on SPCE surface were examined by electrochemical impedance spectroscopy (EIS) and cyclic voltammetry (CV) method. Textural and micro-structural properties of SPCE were investigated by scanning electron microscopy (SEM) and energy dispersive X-ray (EDX) spectroscopy. Bonding of a self-assembling monolayer (SAM), an antibody, and an antigen on SPCE were also successfully achieved. After each layer formation, EIS tests were performed using the redox probe potassium ferricyanide (K₃[Fe(CN)₆]) at the both optimum concentration and parameters. The impedance data were presented in the Nyquist curves. The Nyquist plot provides charge transfer resistance (Rct) when employed along with the equivalent circuit model. The results showed that the Rct values increased with the formation of additional layers. The increasing resistance showed a successful achievement of the immobilization process.

Keywords: Biosensor, Screen-Printed Carbon Electrode, Immobilization, Electrochemical Impedance Spectroscopy, Cyclic Voltammetry

1. Introduction

Screen-printed electrodes (SPEs) are widely used in electrochemical sensor systems owing to the advantageous features including low-cost, ease of use, high reproducibility, and high sensitivity. The presented advantages of SPEs enable these electrodes use in different type of applications such as analytical chemistry, biochemistry, medicine, environmental protection, food safety, and pharmacy. Compared to the conventional electrodes, the SPEs exhibit rapid analysis and reliable results. The SPEs also provide in situ analyses. Therefore, techniques in electrochemical processes. EIS is a non-destructive measurement that can provide beneficial insights into the identification and quantification of electrode characteristics. EIS measurements allow discriminating time constants related to the processes occurring at the electrolyte/electrode interfaces. Cyclic voltammetry analyses provide information for the electrochemical reaction mechanisms between the electrolyte and SPEs. Compared to the conventional CV method, EIS measurements provide more detailed it is of great significance to characterize the features of the SPEs. To determine the characteristic properties of the SPEs, numerous methods have been applied. Electrochemical impedance spectroscopy (EIS) and cyclic voltammetry (CV) are the most widely used information about the electrochemical processes.

In this study, the immobilization of SPCEs was carried out to prepare the SPE-based biosensor. EIS analysis was performed by using potassium ferricyanide to present the steps of stable immobilization onto the SPCEs surface. The changes on the surface of SPCEs were characterized by SEM and EDX.

2. Materials and Method

Immobilization and electrochemical experiments were performed on commercial screen printed carbon electrode. Cyclic voltammetry and impedance spectroscopy were used to monitor changes associated with immobilization steps.

2.1. Materials

Commercial 110 AT SPCEs with the electrode surface area of 0.1256 cm² were purchased from Metrohm DropSense. EIS and CV measurements were performed using a Gamry 3000 Potentiostat/Galvanostat/ZRA connected to a desktop computer. The experimental setup for the electrochemical measurements is presented in Figure 1. The external morphology of SPCEs was characterized by a Hitachi Regulus 8230 scanning electron microscope (SEM) at 20 kV. The elemental composition of SPCEs surface was also investigated by using combined SEM-EDX instrument mentioned above.
2.2. Methods

The surface of SPCE is first coated with a self-assembled monolayer (SAM) using 11-mercaptoundecanoic acid (11-MUA), followed by immobilization of streptavidin (SPV) by covalent bonding with 11-MUA through the carbodiimide reaction in an immobilization procedure. The SPCE was rinsed by anhydrous ethanol and 11-mercaptoundecanoic acid (MUA, 10 mM prepared in anhydrous ethanol, Sigma). After one-hour incubation of MUA, it is rinsed with ethanol and Dulbecco's phosphate-buffered saline to remove unbounded thiols. Then desired layers were formed on the surface of SPCEs. Then, antibodies were attached to SPV via strong interaction between SPV and biotin. The electrochemical characterization of SPCEs was carried out based on the change of electron transfer kinetics of redox probe potassium ferricyanide (5 mM K$_3$Fe(CN)$_6$). CV measurements were performed at a potential range of 0-1.6 V and 100 mV/s scan rate. Impedance measurements were performed at the open circuit potential with the 10 kHz-100 mHz frequency range.

![Fig. 1 Experimental setup; a) screen printed carbon electrode (SPCE), b) SPCE connector, c) Gamry instruments reference 3000 Potentiostat, d) Desktop computer](image)

3. Result and Discussion

The immobilization steps are presented in Figure 2. The surface was activated through the formation of carboxylic groups on the SPCE. The activation of surface was achieved by the CV with the phosphate-buffered saline solution. The cyclic voltammogram is presented in Figure 3. In the second step (Figure 2.b), the surface of SPCE was functionalized by immobilizing a self-assembling monolayer (SAM) from spacers containing thiol groups on one end and carboxyl groups on the other terminal. SAM formation enables the surface to be more stable for the subsequent interactions. After the functionalization step, antibody was attached to the antigen via strong interaction. In the end, the SPCE can attach the toxin onto its surface.

![Fig. 2 Schematic diagram of immobilization of SPCE: (a) surface activation, (b) self assembled monolayer (SAM), (c) antibody, (d) toxin capture](image)

![Fig. 3 Cyclic voltammograms of SPCE recorded in 0-1.6 V potential range and 100 mV/s scan rate, three cycles in acetate buffer solution with pH=4.6](image)

The impedance response for the immobilization steps including SAM, antibody, and toxin attachment is presented in Figure 4. The impedance data were modeled to capture the physically meaningful circuit parameters. An equivalent circuit was used to reflect the impedance behavior of the immobilization steps. The equivalent circuit consists of three elements. $R_e$, CPE, and $R_{ct}$ parameters represent the ohmic resistance, capacitive behavior, and charge-transfer resistance, respectively. The impedance data could not be described simply by a Randles circuit design since the Nyquist plot is not a perfect semi-circle. The high frequency response was
modeled by using a constant-phase element (CPE) with \( \alpha_c \) and \( Q_c \). The modeling results showed that the charge-transfer resistance increased after each of the immobilization steps. The increase in \( R_{ct} \) demonstrated the formation of layers on the SPCE.

![Graph](image)

**Fig. 4**  Electrochemical impedance spectroscopy analysis for the immobilization steps: (A) Nyquist representation of the impedance responses and the equivalent circuit model used to fit the impedance data; (B) charge transfer resistance values during the immobilization steps.

SEM images of the surface of SPCE are presented in Figure 5. The surface after the immobilization was smoother while the bare electrode surface was rough. Compared with the surface of immobilized SPCE, the surface of bare electrode was more uniform. The SEM images indicated that the additional layer formed on the bare electrode surface after the immobilization. The thicker surface caused the increase in \( R_{ct} \). EDX analyses showed that the working surface of bare electrode consisted of carbon (96 wt.%), oxygen (3 wt.%) and chlorine (1 wt.%). After the immobilization processes, the elemental composition of the surface was changed. The contents of carbon, nitrogen, oxygen, and chlorine were 70 wt.%, 12 wt.%, 14 wt.%, and 2 wt.%, respectively.

![SEM images](image)

**Fig 5.** SEM images of surface of SPCE: (a) bare SPCE before immobilization, (b) after immobilization

4. Conclusions

This work provides a detailed characterization of the screen-printed carbon electrodes. The applied of cyclic voltammetry in 0-1.6 V potential range formed additional layers on the surface of SPCE. Electrochemical impedance responses were modeled by the developed equivalent circuit model. The charge-transfer resistance values obtained by the equivalent circuit modeling and the subsequent analyses including SEM and EDX demonstrated formation of layers on the surface of SPCE after the immobilization steps. This work provides guidance for the characterization and optimum use of commercially available screen printed electrodes.

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