



Original scientific paper

Scaling-ion removal from high-salinity produced water *via* sono-electrocoagulation: interplay of floc microstructure and electrochemical surface activity

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Abstract

Produced water from oil fields contains complex dissolved organic and inorganic species, including Ca^{2+} , HCO_3^- , and CO_3^{2-} , which induce CaCO_3 scaling and hinder waterflooding operations. This study investigated the performance of electrocoagulation (EC) and ultrasonic-assisted electrocoagulation (sono-EC) for treating native produced water from Indonesian oil fields, focusing on scaling ion removal, floc structural characteristics, and hydrogen evolution. Experiments were conducted at pH 5, 7 and 9 using Al-SS316 electrodes under constant current conditions, with intermittent sonication applied to enhance Al^{3+} release and suppress electrode passivation. The results demonstrated that pH 7 provides optimal conditions for the formation of stable amorphous $\text{Al}(\text{OH})_3$ flocs. Scanning electron microscopy analysis revealed a porous lamellar morphology that promotes ion adsorption and co-precipitation, resulting in the highest removal efficiencies of Ca^{2+} , HCO_3^- and chemical oxygen demand (COD). Sonication further enhanced process performance by inducing cavitation-driven micro-mixing, accelerating floc growth, and increasing hydrogen evolution. Brunauer-Emmett-Teller and Barrett-Joyner-Halenda analyses confirmed pronounced pH-dependent differences in floc porosity and surface characteristics, which mechanistically explained variations in ion capture behaviour. Overall, the sono-EC operated at neutral pH offers an effective strategy to mitigate scaling potential, while hydrogen evolution is used as an electrochemical indicator of cathodic surface activity.

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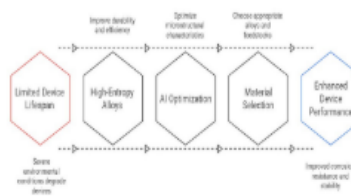
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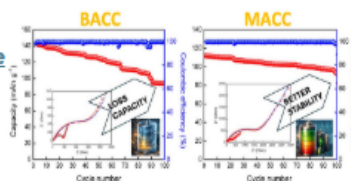


Comparative study of 2D perovskite cathodes: impact of organic cation variation on electrochemical performance in lithium-ion batteries

Original scientific paper

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Dewendra Tharal, Shams Thader, Tawad Shaqra, Mohammed Saqda Khan, Kholma Kumar Tharal, Raneppu Sathish
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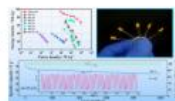


CoNi₂O₄ embedded in graphene nanosheets as an advanced intercalation anode for high-energy lithium-ion capacitors

Original scientific paper

Taozhong Wei, Yu Zhang, Popen Ma, Yuxuan Chen, Chidong Ma, Shiyi Zhang, Changping Huo, Zhongli Zou, Rui Chang
J Electrochem. Sci. Eng. Vol. 14 (2024), 2421
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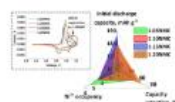


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Original scientific paper

Hui Anna Liu, Muhd Fadzlan Khatin, Khatim Rung, Zariah Irfan, Saidi Mustafiz Ramli, Lailatul Izzah, Azzah Asadul, Nurul Adnan Mohd Noh, Muhammad Rami Yusoff
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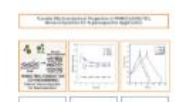


Tunable electrochemical properties of polyaniline/CuO/BaTiO₃ nanocomposites for supercapacitor application

Original scientific paper

Geeho Joseph, Arjunant Goparth, Yerra Ravi Mohan, Akar Jose, Akar Joseph, Ganesh Kumar Nagarajan Pillai, Saba Suresh, Gok, Gokan S Joseph
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Electroanalytical Chemistry

Silver-doped TiO₂ nanotube array nanosensor for gallic acid detection: active surface and electrochemical enhancement

Original scientific paper

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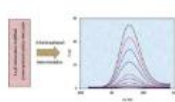


Highly sensitive voltammetric nanosensor based on Cu₂O nanocubes modified screen-printed carbon electrode for determination of 4-aminophenol

Original scientific paper

Mahmoud Kamel Elam, Khalil Mohamed Ahmed, Ahmad M. J. Khan, Yih, Zhusha Rami Khatib
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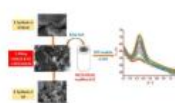


NiFe₂O₄/S,Ni-doped graphene oxide composite as efficient electrochemical sensor for determination of ibuprofen in dietary supplements

Original scientific paper

Hui Thi Thanh Xuan, La Thi Thanh Nhi, Nguyen Quang Man, Yu Thi Khanh Uy, La Thi Hong Phung, Nguyen Hai Phung, Pham Khai Linh, La Lam Son, Dinh Quang Khieu
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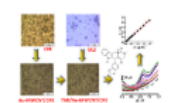


Tadafall electrooxidation on gold and MWCNT-based nanocomposites modified carbon paste electrodes: comparative study and analytical application

Original scientific paper

Jasmina Anzic, Sanja Muri, Sanja Geroncic, Miroslav D. Stasich, Dubravka Klobucar, Zdenka Klobucar, Miroslav Anzic
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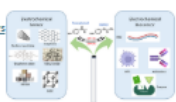


Next-generation electrochemical sensors and biosensors for paracetamol detection: emerging trends and future perspectives

Review paper

Sandesh Kumar, Vigneshan, Jyoti Singh, Chandra Kumar, Prakash Narayan
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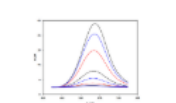


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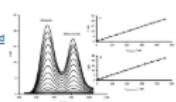


Electrochemical detection of glitazide and glimepiride on metal organic framework/multi-walled carbon nanotubes nanocomposite modified screen printed electrode

Original scientific paper

Shahin Ali Alghar, Omar, Shaban Ali Alsaedi, Mohamed Ahmad, Mohamed Alghar, Shaban Ali Alsaedi
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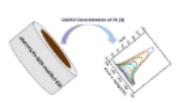


Synthesis of Fe-based metal organic framework/MWCNTs for modification of glassy carbon electrode: application in the efficient stripping voltammetric determination of Pb(II) ions

Original scientific paper

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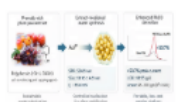


Phenolic-rich plum peel extract-mediated synthesis of gold nanoparticles for electrochemical detection of Pb(II)

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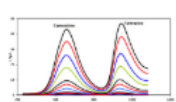


Graphene oxide/NiO nanocomposite-modified carbon paste electrode for the simultaneous detection of carmotidine and tartrazine as two dyes in food samples

Original scientific paper

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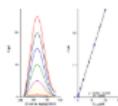
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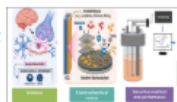
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Recent developments in electrochemical biosensors based on nanomaterials for dopamine detection: a brief overview
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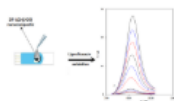
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Highly sensitive and selective electrochemical determination of ciprofloxacin using modified screen-printed electrode
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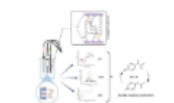
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Ultrasensitive and selective electrochemical sensor for paracetamol based on thiadiprid nanocomposite
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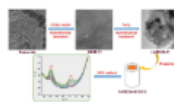
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Determination of acetaminophen and theophylline in drug samples by electrochemical method using Fe/Ni-M-M-41 modified electrode
Original scientific paper

Ruph Thanh Danh, Nguyen Chi Sai, Nam Thi Nguyen Thoa, Nguyen Quang Nam, Phan Dinh Du, Dinh Quang Khieu
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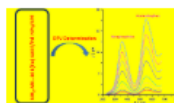
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Synergistic effects of NH₂-MIL-101(Fe) metal-organic framework and Pd nanoparticles for sensitive determination of norfloxacin in the presence of acetaminophen
Original scientific paper

Shaimaa A. Jado, Ashraf Farouq, Tarek M. Badhi, Hamed A. Tashit, Jorhan A. Haseb
J Electrochem. Sci. Eng. Vol. 14 (2020), 2144
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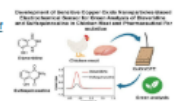
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Sustainable electrochemical sensor for green analysis of diazepam HCl and sulphamonomoxime Na in food and pharmaceutical samples
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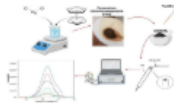
Mohd Abd El-Aziz, Radeef T. Marik, Maha Elshakry, Marina I. Kaimy, Saba Mohamed, Lohana M. Abd El-Hakim
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Ferrocenyl tetrachloromagnesium modified MWNTs electrode for detection of B³⁺ at the trace level in polluted aqueous solutions
Original scientific paper

Tahadun Tahar, Abul Yousuf, Nurfarhan Shahrin, Mohamed Ibrahima Salim, Mohamed Syahrial Ahmad, Siti Nur Akmar Mohd Yusoff, Shamsul Hameed Mohd Shahril, Nura Haniffa Yusoff
J Electrochem. Sci. Eng. Vol. 14 (2020), 2466
Published 02-02-2020, DOI: <https://doi.org/10.22298/jee.2466>



Electrochemical sensing of atenolol using silver-reduced graphene oxide carbon paste nanocomposite electrode
Original scientific paper

Mervat Smol, Sadiq Cenali, Lorena Toldu, Majida Yagari, Ana Amado, Loida Ruiz
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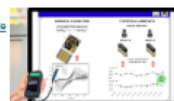
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Validation of a low-cost carbon screen-printed electrode platform: a statistical approach
Original scientific paper

Jolene Morris de Paula, Thomas Henrique de Cunha Silva, Luciana Silva de Almeida, Celia Henrique Pinho Rodrigues, Alina Trass Smol, Mariana Fomina de Oliveira
J Electrochem. Sci. Eng. Vol. 14 (2020), 2144
Published 02-02-2020, DOI: <https://doi.org/10.22298/jee.2144>

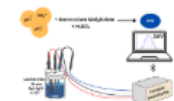
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Rapid and sensitive electrochemical determination of phosphate ions using a multi-walled carbon nanotube carbon paste electrode
Original scientific paper

Cenelma Smol, Mervat Smol, Lorena Toldu, Sonia Toldu, Sadiq Cenali
J Electrochem. Sci. Eng. Vol. 14 (2020), 2144
Published 02-02-2020, DOI: <https://doi.org/10.22298/jee.2144>

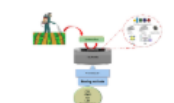
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Recent advances in nanomaterials-based electrochemical sensors for herbicide detection
Review paper

Ali Ghadi Ibrahim, Sadiq Mohammad Thiyab, Muhammad Abdul Raean Khalil, Rayha A. Mubarak, Asad Amer Hadi, Emad Saleem Abbas
J Electrochem. Sci. Eng. Vol. 14 (2020), 2466
Published 02-02-2020, DOI: <https://doi.org/10.22298/jee.2466>

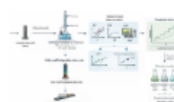
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Electropolymerized poly(methylene blue)-modified graphite electrode for phosphate detection
Original scientific paper

Ana Lucia Ferreira de Barros, Leandro Marques Senry, Yllean Lima, Raydonan Sorrell Sales
J Electrochem. Sci. Eng. Vol. 14 (2020), 2144
Published 02-02-2020, DOI: <https://doi.org/10.22298/jee.2144>

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Electrochemical detection of malatonin using Cd-doped ZnO nanoparticles modified carbon paste electrode
Original scientific paper

Mahmoud Fathi, Jyoti R. Khol, Sahadurrahman Saharwan, Ramer Sanyal, Lamartini Ghannouchi, Mervat Smol
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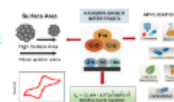
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Transition metal oxide-modified carbon electrodes: A comprehensive review on surface area modulation and analytical electrochemical insights
Review paper

Krushika Manohara Selamanna, Gurung Roder Jyaprasad
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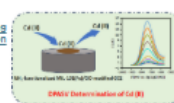
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Enhanced anodic stripping determination of Cd(II) using NH₂-functionalized MOF and GO-modified glassy carbon electrode
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Muhammad Abdul Raean Khalil, Yllean A. Salinas, Ashraf Ali Khadim
J Electrochem. Sci. Eng. Vol. 14 (2020), 2144
Published 02-02-2020, DOI: <https://doi.org/10.22298/jee.2144>

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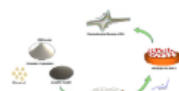


Poly(paspargel)-modified duplex stainless steel composite carbon paste electrode for selective electrochemical detection of dopamine

Original scientific paper

Shashantha Rajendrachari, Hananatha Nagarajappa, Thirun Corralana Velalanchana, Balakrishna Gannadpuram Shrinani, Zaini Sami, Ganesh Anandaraman, Ramji Toden Ramaraj
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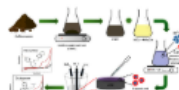


Fabrication of Iridium-gold nanocomposite for the detection of selective serotonin reuptake inhibitors

Original scientific paper

Simona Barry, Candice Ogilvie, Reagan Polgas, Talsadat Moloudi, Rashid Farah, Yiguo Wang
J Electrochem. Sci. Eng. Vol. 16 (2020), 2016
Published 10-10-2020, DOI: <https://doi.org/10.2299/jees.2016>

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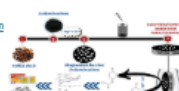
Development of a modified electrode using magnesium ferrite/activated carbon from coffee shell for determination of paracetamol

Original scientific paper

Phan Thi Kim Thu, Phan Tu Quy, Nguyen Mau Thanh, Nguyen Quang Nam, Nguyen Hai Phong, Dinh Quang Khieu
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Published 10-10-2020, DOI: <https://doi.org/10.2299/jees.2044>

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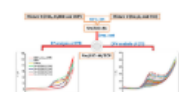
Sn/UO₂-66 Modified Electrode for the Electrochemical Determination of Ethamboutyl Hydrochloride in Pharmaceutical Formulations and Human Urine

Original scientific paper

Pham Thi Nguyen Thoa, Nguyen Quang Nam, Phan Tu Quy, Nguyen Chi Sao, Le Van Thanh Son, Le Lam Son, Dao Ngoc Nham, Dinh Quang Khieu
J Electrochem. Sci. Eng. Vol. 16 (2020), 2212
Published 10-10-2020, DOI: <https://doi.org/10.2299/jees.2212>

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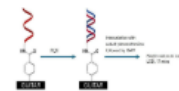
Rapid single-molecule detection of Salmonella DNA based on an electrode surface-based polymerase chain reaction technique

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Michael Okello, Olipak Kozhala, Mithar Rashid, Gian Soderqvist, I. Francis Chang
J Electrochem. Sci. Eng. Vol. 16 (2020), 2412
Published 10-10-2020, DOI: <https://doi.org/10.2299/jees.2412>

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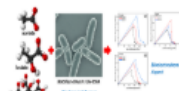


Carboxylate-controlled electron transfer in *Bacillus clausii* MIC-RBS halophilic microbial fuel cells

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J Electrochem. Sci. Eng. Vol. 16 (2020), 2020
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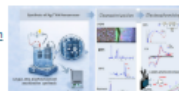


Bismuth molybdate nanostructure modified carbon paste electrode for voltammetric sensing of levodopa in the presence of acetaminophen

Original scientific paper

Abdul Amir M. Radwan, Ahmad J. Alami, Rajir M. Ali, Rada Radwan
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Published 10-10-2020, DOI: <https://doi.org/10.2299/jees.2124>

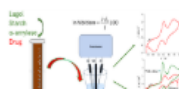
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Electrochemical assessment of α -amylase inhibition by type 2 diabetes drugs: a cyclic voltammetry study

Open communication

Touhami Lelkes, Elzaboud Lelkes, Alina Adina
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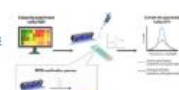
Parameter selection of cerium oxide anodic electrodeposition on screen-printed carbon electrodes using response surface methodology for nucleic acid based biosensors

Original scientific paper

Glenn Yuhan Sharmadani, Art Rindarno, Muhammad Sula Hantoro, Lili Kusumawati, Sari, Satrio Nur Zakriyah, Yetti Yagayanti, Nurani, Triham
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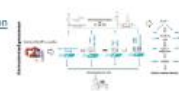


Electrochemical genosensor for detection of a mutation in the adenomatous polyposis coli gene (APC 1306)

Original scientific paper

Lisbeth Espinosa Garcia, David Garcia Garcia, Eduardo O. Mordredo-Garcia, Eduardo Mordredo-Garcia, Tania Alvarez-Gonzalez, Javier Escobar (Tramenes-Gonzalez), Pablo Guzmán-Durán, Maritza Cruz, José Alberto García-Rodríguez, Soledad Carrasco-López, Joaquin Carrasco-Hernandez, Carlos Pérez-Ramírez, Yiguo Wang, Mariana Rodríguez Villalón Barrios, Luis Fernando García-Melo
J Electrochem. Sci. Eng. Vol. 16 (2020), 2109
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Corrosion

Synthesis and characterization of an inorganic-organic nanomaterial for use as corrosion inhibitor for mild steel in HCl

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Machembwa Nkomo Mchizi, Teloma Scholarios Oelochi, Adewale Prince Adewole, Williams Nwae Adamo, Aducci Ogha Daniel
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Mango peel extract as a green inhibitor in the corrosion of reinforced concrete

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Alexandro Flores-Rodríguez, Elia Carmina Manríquez-Campa, María Flores-Rodríguez
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Published 10-10-2020, DOI: <https://doi.org/10.2299/jees.2474>

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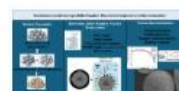
Electrodeposition And Coatings

Electroless cobalt coating of BNi-1 powders: process development and characterization

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Tarek Ghyssels, Tarek Hawkeya
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Progress in eco-friendly aerospace coatings: the future beyond chromates

Review paper

Shahana Rishat, Rishat Jeyapalan, R. Arumugam
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Published 10-10-2020, DOI: <https://doi.org/10.2299/jees.2172>

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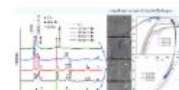


Effect of composition and crystal structure of CoNi alloys on electrocatalytic properties and hydrogen interaction

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Tulay Yagcioglu, Elina Onay, Oksana Tyshchenko, Tatyana Kabanova
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Study of the electroreduction process of indium ions from aqueous electrolyte

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Advances and challenges of SnO₂-based anodes for electrochemical wastewater treatment

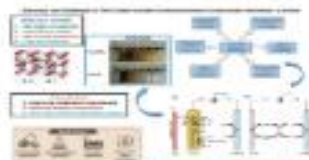
Review paper

Ghuldas A. Irmak, Ali H. Abbar

J. Electrochem. Sci. Eng., Vol. 16 (2020), 2042

Published 12-07-2020, DOI: <https://doi.org/10.2299/jee.2042>

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Electrocoagulation as an effective all-in-one wastewater treatment: a critical review

Review

Kiran Tota-Maharaj, Martin Eastwood, Aya Galib, Tamas M.

Small, Chadly Thiaud, Rakesh Gouda, Upaka Rathnayake,

Abraham Nagarath

J. Electrochem. Sci. Eng., Vol. 16 (2020), 2024

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Electrochemical oxidation of textile wastewater combined with 185 nm UV irradiation

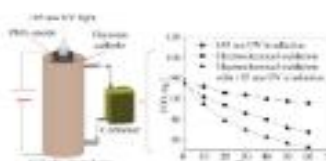
Original scientific paper

Chao Yang, Penghao Tian

J. Electrochem. Sci. Eng., Vol. 16 (2020), 2006

Published 16-11-2019, DOI: <https://doi.org/10.2299/jee.2006>

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Electrocoagulation for industrial wastewater remediation: efficiency, operational optimization and sustainable implementation

Review paper

Fernando Garcia-Arta, Christopher Garcia-Urda, Samantha

Quispeflora-Silva, Maria J. Salazar-Arriola, Mariana Segura-

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J. Electrochem. Sci. Eng., Vol. 16 (2020), 2008

Published 14-01-2020, DOI: <https://doi.org/10.2299/jee.2008>

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Ultrasound-enhanced water electrolysis for hydrogen production: Mechanisms, metrology and energy metrics

Review paper

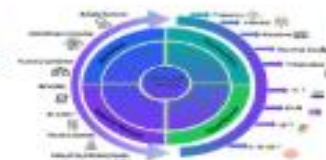
ChenRongWen Zeng, Yuxiang Tang, Weiwei Ge, Xing, Mohamed

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J. Electrochem. Sci. Eng., Vol. 16 (2020), 2042

Published 22-01-2020, DOI: <https://doi.org/10.2299/jee.2042>

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Electrochemical surface modification of Ti6Al4V: positioning electrochemical machining as a low-valence dissolution pathway for enhanced performance

Review paper

Rishabh Upadhyay

J. Electrochem. Sci. Eng., Vol. 16 (2020), 2076

Published 01-02-2020, DOI: <https://doi.org/10.2299/jee.2076>

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Scaling-ion removal from high-salinity produced water via sono-electrocoagulation: Interplay of floc microstructure and electrochemical surface activity

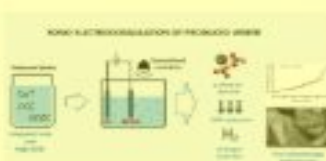
Original scientific paper

Rana Prabhat, Kartika Rajarajendran, Manan Dhanraj, Dina Ameen Chaudhary, Wafic Zahedi, Thor Elysebeth

J. Electrochem. Sci. Eng., Vol. 16 (2020), 2127

Published 22-04-2020, DOI: <https://doi.org/10.2299/jee.2127>

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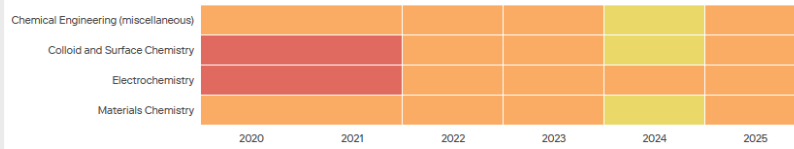
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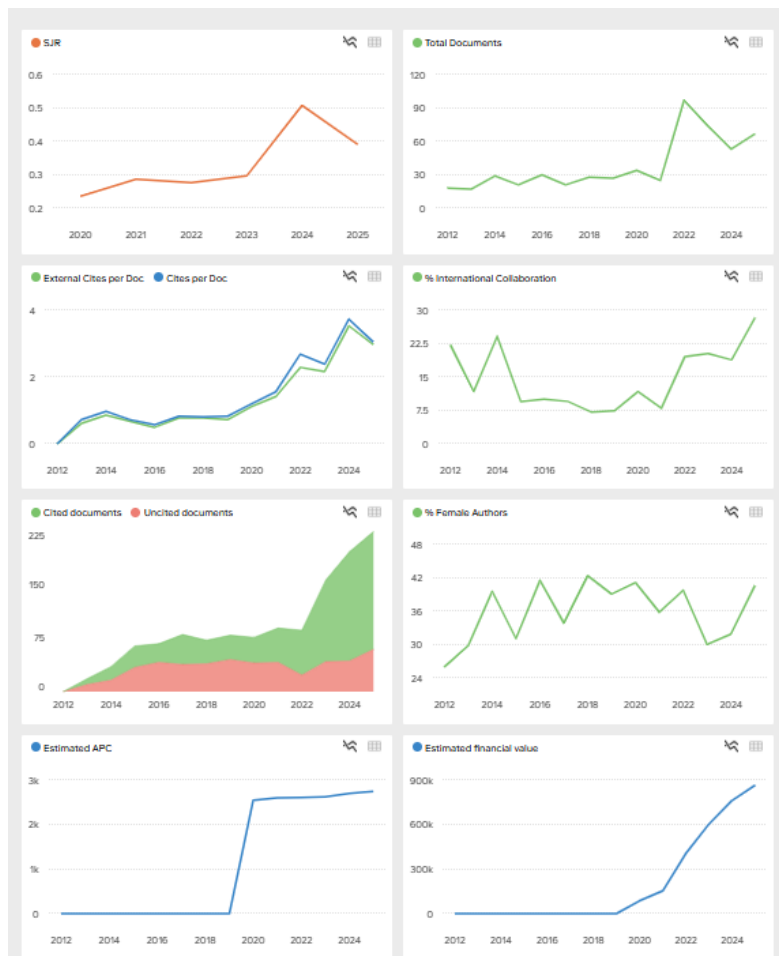
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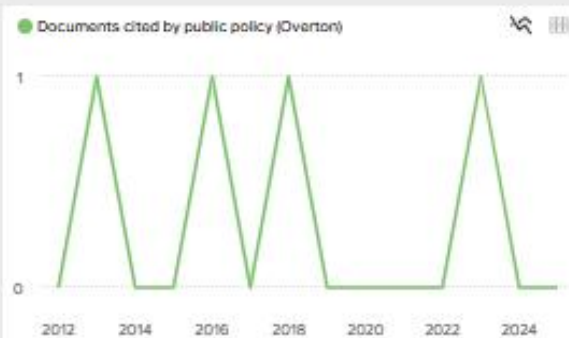
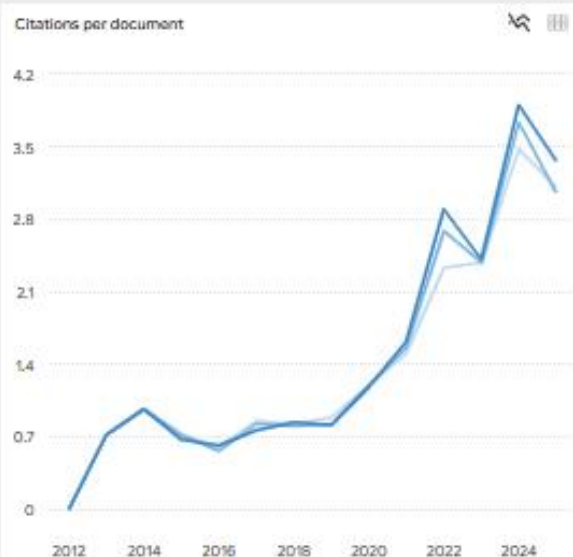
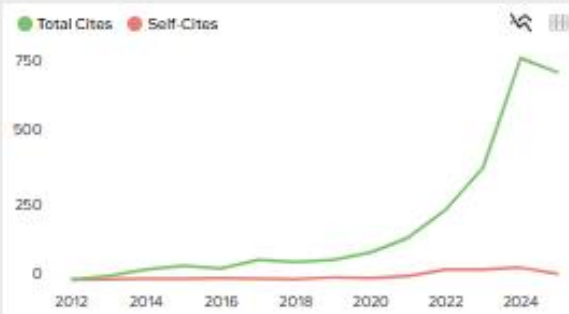
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Scaling-ion removal from high-salinity produced water via sonoelectrocoagulation: interplay of floc microstructure and electrochemical surface activity

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Abstract

Produced water from oil fields contains complex dissolved organic and inorganic species, including Ca^{2+} , HCO_3^- , and CO_3^{2-} , which induce CaCO_3 scaling and hinder waterflooding operations. This study investigated the performance of electrocoagulation (EC) and ultrasonic-assisted electrocoagulation (sono-EC) for treating native produced water from Indonesian oil fields, focusing on scaling ion removal, floc structural characteristics, and hydrogen evolution. Experiments were conducted at pH 5, 7 and 9 using Al-Si356 electrodes under constant current conditions, with intermittent sonication applied to enhance H_2 release and suppress electrode passivation. The results demonstrated that pH 7 provides optimal conditions for the formation of stable amorphous Mg(OH)_2 flocs. Scanning electron microscopy analysis revealed a porous lamellar morphology that promotes ion adsorption and co-precipitation, resulting in the highest removal efficiencies of Ca^{2+} , HCO_3^- , and chemical oxygen demand (COD). Sonication further enhanced process performance by inducing cavitation-driven micro-mixing, accelerating floc growth, and increasing hydrogen evolution. Brunauer-Emmett-Teller and Barrett-Joyner-Halenda analyses confirmed pronounced pH-dependent differences in floc porosity and surface characteristics, which mechanistically explained variations in ion capture behaviour. Overall, the sono-EC operated at neutral pH offers an effective strategy to mitigate scaling potential, while hydrogen evolution is used as an electrochemical indicator of cathodic surface activity. © 2026 by the authors.

Author keywords

cavitation; depassivation; electrochemical removal; Faradaic efficiency; flocs characterisation; hydrogen evolution; Produced water pollutants; scale causing ions; ultrasonic treatment