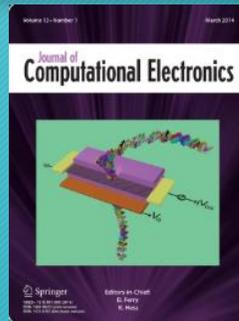E. B. Yurdakul, *A. Yildiz*, S. E.Ela, Y. Erdogdu
Cutting-edge dyes for p-type dye-sensitized solar cells: a theoretical study of 1,8-naphthalene imide derivatives

Published in *Journal of Computational Electronics*,

September 2025

(Q3, Impact Factor: 2.5)

Recently published by

Prof. Dr. Abdullah YILDIZ, Energy Systems Engineering

Cutting-edge dyes for *p*-type dye-sensitized solar cells: a theoretical study of 1,8-naphthalene imide derivatives

Emre Burak Yurdakul[1,2] · Abdullah Yildiz[3] · Sule Erten Ela[4] · Yusuf Erdogdu[1]

Abstract
We report a theoretical investigation of the designed 1,8-naphthalene imide-based dyes for application in *p*-type dye-sensitized solar cells (*p*-DSSCs). The designed dyes are metal-free organic molecules combined with a carbazole donor, a naphthalene imide acceptor, and a cyanocarboxylic acid anchoring group. Different linkers, including benzothiadiazole, phenyl, furan, and thiophene, were introduced to modify their properties. The *p*-DSSCs were theoretically evaluated with five various *p*-type semiconductors (CuO, Cu_2O, $CuGaO_2$, $CuCrO_2$, and $CuAlO_2$) and six various electrolytes based on cobalt and copper complexes. Computational analysis was performed by means of Density Functional Theory (DFT) and Time-Dependent DFT (TD-DFT). For all designed dye, the HOMO levels were sited below the valence band of the semiconductors, while the LUMO levels were located above the redox potential of the electrolytes. This alignment confirms hole injection and dye regeneration. The results show that the dyes, especially those with benzothiadiazole and phenyl linkers, are promising dyes for improving *p*-DSSC efficiency through enhanced light harvesting, effective charge separation, and reduced recombination losses. These findings contribute valuable insights into the design of high-performance *p*-type photosensitizers for tandem DSSC applications.

K. Ozel, S. Gürakar, *A. Yildiz*
Annealing Temperature-Driven Evolution of Structure, Morphology, and Optical Behavior in Cu-TiO2 Composite Films
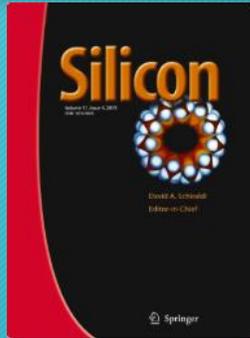
Published in *Silicon,*

September 2025

(Q2, Impact Factor: 3.3)

Recently published by

Prof. Dr. Abdullah YILDIZ,
Energy Systems Engineering

Annealing Temperature-Driven Evolution of Structure, Morphology, and Optical Behavior in Cu-TiO$_2$ Composite Films

K. Ozel[1] · S. Gürakar[2] · T. Serin[2] · A. Yildiz[3]

Abstract
In the present study, we investigate how varying annealing temperatures affect the structural, morphological, and optical properties of copper-titanium oxide composite films deposited on quartz substrates. A range of characterization techniques, including X-ray diffraction, Raman spectroscopy, scanning electron microscopy, atomic force microscopy, and UV–Vis spectroscopy, were employed to analyze the changes in film characteristics. The results demonstrate that annealing temperature plays a critical role in determining the film's structural integrity, surface morphology, and optical behavior. The crystallite size increased from 16.97 nm at 500 °C to 68.07 nm at 900 °C, while surface roughness rose significantly, reaching 148 nm at 1000 °C. In addition, SEM analysis showed that particle size expanded from 12.55 nm at 400 °C to 603.60 nm at 900 °C. Notably, a strong relationship was found between film transparency and these physical properties, with optical transmittance decreasing from approximately 69% at 400 °C to around 2% at 1000 °C. Based on the findings, the study proposes optimal annealing conditions for achieving high-quality thin films.

A. Yildiz

Cs Content-Dependent Photovoltaic Performance of CsxRb1−xPbI3-Based Perovskite Solar Cells

Published in *Physica Status Solidi (a) – Applications and Materials Sciencen, September 2025*

(Q2, Impact Factor: 1.9)

Recently published by

Prof. Dr. Abdullah YILDIZ, Energy Systems Engineering

Cs Content-Dependent Photovoltaic Performance of Cs$_x$Rb$_{1−x}$PbI$_3$-Based Perovskite Solar Cells

Abdullah Yildiz

All inorganic perovskite materials consisting of Cs and Rb cations offer an exciting opportunity to fabricate more tunable absorber layers for highly stable solar cell devices. Herein, a 1D solar cell capacitance simulator (SCAPS-1D) is utilized to comprehensively study the photovoltaic performance of all-inorganic Cs$_x$Rb$_{1−x}$PbI$_3$-based perovskite solar cells as a function of Cs content (x). The input parameters of SCAPS 1D, such as electron and hole mobilities, are evaluated as a function of x for Cs$_x$Rb$_{1−x}$PbI$_3$. Equations for x-dependent photovoltaic parameters are derived. Superstrate n–i–p solar cell processed with architecture of ITO/TiO$_2$/Cs$_x$Rb$_{1−x}$PbI$_3$/P3HT/Au achieves a promising power conversion efficiency of over 11%. Simulations are also carried out to determine device performance by varying interface defects, series, and shunt resistance as a function of x. The device that obtained $x = 0.2$ of Cs content withstands various rigorous effects of varying interface defects, series, and shunt resistance. The findings presented herein will promote the development of all-inorganic Cs$_x$Rb$_{1−x}$PbI$_3$ perovskite-based solar cells.

difficult to use in thin-film form. On the other hand, RbPbI$_3$ significantly improves phase stability under environmental conditions, which makes it a suitable light-absorber candidate for usage in solar cells.[9,10] When a mixture of RbPbI$_3$ and CsPbI$_3$ is added, it causes them to quickly and completely transform into the photoactive α-phase perovskite. The device based on this mixture outperforms its counterpart based on CsPbI$_3$ in terms of stability and power conversion efficiency (PCE).[11]

Lead halide perovskites privileged to have solar cell applications can reduce costs and reach power conversion efficiencies exceeding 25%. The disadvantage of such PSCs is the stability and toxicity, which hinder their commercialization. Cs$_x$Rb$_{1−x}$PbI$_3$ is a subclass of all-inorganic lead halide perovskites in which cesium (Cs$^+$) is substituted for

Akın İLHAN
Water Flow Rate Assessment of Different Water Flow Metering Stations, by means of Probability Analyses of Data Classes and Mathematical Expression of River Water Flow Rate Measurement

Published in *5TH INTERNATIONAL CONFERENCE ON FRONTIERS IN ACADEMIC RESEARCH, September 2025*

Recently published by

Assc. Prof. Dr. Akın İLHAN
Energy Systems Engineering

ALL SCIENCES ACADEMY

Proceeding Book of 5th International Conference on Frontiers in Academic Research ICFAR 2025
September 25-26, 2025, Konya, Turkey

5th International Conference on Frontiers in Academic Research

September 25-26, 2025; Konya, Turkey

© 2025 Published by All Sciences Academy

ICFAR

https://www.icfarconf.com/

Water Flow Rate Assessment of Different Water Flow Metering Stations, by means of Probability Analyses of Data Classes and Mathematical Expression of River Water Flow Rate Measurement

Akın İlhan[*]

[1]Department of Energy Systems Engineering, Ankara Yildirim Beyazit University, Faculty of Engineering and Natural Sciences, Ankara, Türkiye

[*](akinilhan@aybu.edu.tr)

Abstract *– In this study, instantaneous measured water flow rates of four water flow measurement stations, located on two different rivers were analyzed in terms of data classes and a mathematical description of flow measurement technique was made. While the rivers included Arda and Tunca, found in north-west provinces of Thrace region of Türkiye; water metering stations taken into account comprised of Ivoylovgrad, Elhova, Suakacağı, and Değirmenyeni found on these rivers. The average volumetric water flow speeds of rivers on these measurement stations were reported to correspond to 33.77 m^3/s, 9.58 m^3/s, 14.36 m^3/s, 29.96 m^3/s, respectively for Ivoylovgrad, Elhova, Suakacağı, and Değirmenyeni measurement stations. The probability analyses performed on water flow rates of two rivers have demonstrated that flow characteristics of these two rivers are generally calm. Namely, it is reported that Arda river flows with a flow speed smaller than 40 m^3/s with a probability of the proportional cumulative frequency of 81.17% according to the measurements executed on Ivoylovgrad water measurement station, Tunca river drains with a flow speed less than 46 m^3/s based on the probability of the proportional cumulative frequency corresponding to 97.91% with respect to observations actualized on Elhova water metering station, Tunca river streams having a flow velocity minor than 51 m^3/s with regards to probability of proportional cumulative frequency at 95.64% depending on investigations realized on Suakacağı water measurement station, and Tunca river again discharges possessing a flow velocity compact than 38 m^3/s as per the probability of proportional cumulative frequency obtained as 82.51% by means of explorations materialized on Değirmenyeni water metering station.*

Keywords – Volumetric water flow rate measurement, data classes, time-series data distributions, probability analysis

A. Ucar, R. Silva, B. Almarhoon, D. Arcangeli, A. Alqatari, A. Hama, T. Chang, S. Arold, R. Grunberg, S. Inal
Optimizing Nanobody-Based Sandwich Electrochemical Immunosensors for Ultrasensitive Protein Detection
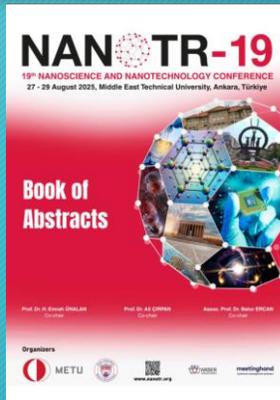
Published in *19th International Nanoscience and Nanotechnology Conference, September 2025*

Recently published by
Assc. Prof. Dr. Ahmet Ucar
Energy Systems Engineering

ID: 53

Optimizing Nanobody-Based Sandwich Electrochemical Immunosensors for Ultrasensitive Protein Detection

Ahmet Ucar * 1,2, Raphaela Silva[1], Bayan Almarhoon[1], Danilo Arcangeli[1], Atheer Alqatari[1], Adel Hama[1], Tianrui Chang[1], Stefan T. Arold[1], Raik Grunberg[1], Sahika Inal[1]

[1] King Abdullah University of Science and Technology (KAUST), Biological and Environmental Science and Engineering (BESE) Division, Thuwal, 23955-6900 Saudi Arabia

[2] Ankara Yıldırım Beyazıt University, Faculty of Engineering and Natural Sciences, Department of Energy Systems Engineering, 06010, Ankara, Turkey

Sandwich-type electrochemical immunosensors are widely recognized for their high specificity, sensitivity, and compatibility with miniaturized, point-of-care diagnostic platforms.[1] By employing a dual-recognition format and enzymatic signal amplification, they enable robust detection of low-abundance biomarkers in complex samples. However, challenges such as non-specific adsorption, inconsistent surface functionalization, and suboptimal assay conditions can compromise reproducibility and sensitivity.[2] These limitations highlight the need for systematic optimization strategies to realize the full potential of such biosensing platforms.

In this study, we present the development and optimization of sandwich electrochemical immunoassays for the detection of the SARS-CoV-2 spike protein and glial fibrillary acidic protein (GFAP), using nanobody/nanobody and nanobody/antibody recognition pairs, respectively. Our optimization strategy focused on three critical assay parameters. First, we compared gold electrode surface functionalization strategies: (i) covalent immobilization of the capture nanobody via a SpyTag-peptide system[3] for oriented and stable attachment, and (ii) direct physisorption of the nanobody onto electrode surfaces. Second, we evaluated two target incubation methods: (i) pre-mixing the target with the horseradish peroxidase (HRP)-conjugated detection nanobody or antibody before application, and (ii) sequential addition of the target followed by the detection unit. Third, we investigated the impact of surface blocking by comparing signal outputs from unblocked electrodes versus those treated with bovine serum albumin (BSA) or casein. Electrochemical detection was carried out via amperometric measurements based on the enzymatic reaction of HRP with 3,3',5,5'-tetramethylbenzidine (TMB) and hydrogen peroxide (H_2O_2). In parallel, colorimetric measurements were also performed for the complementary assessment and validation of assay performance during the optimization process. The results demonstrate that all three parameters significantly affect signal intensity and background response, underscoring the importance of rational sensor design. Furthermore, the optimized immunoassay was integrated into an organic electrochemical transistor (OECT) platform to further enhance sensitivity and signal transduction[4], demonstrating its adaptability for next-generation bioelectronic diagnostics.

D. Karakoca, **A. Ucar**, E. Er
Hybrid immunosensor based on gold nanodendrimer-decorated MoS$_2$ nanoflowers for label-free detection of Alpha-fetoprotein
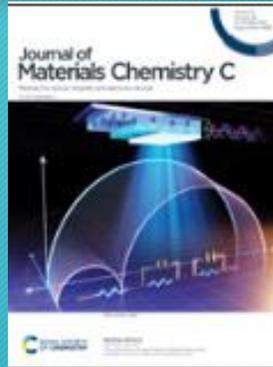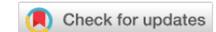
Published in *Journal of Materials Chemistry C, September 2025*

(Q1, Impact Factor: 5.1)

Recently published by
Assc. Prof. Dr. Ahmet Ucar
Energy Systems Engineering

Hybrid immunosensor based on gold nanodendrimer-decorated MoS$_2$ nanoflowers for label-free detection of Alpha-fetoprotein

Deniz Karakoca, Ahmet Uçar and Engin Er

Check for updates

Abstract

This study presents a novel label-free immunosensor for the ultrasensitive detection of alpha-fetoprotein (AFP), based on the uniform decoration of hybrid nanostructures comprising molybdenum disulfide nanoflowers (MoS$_2$NFs) and chiral gold nanodendrimers (AuNDs). In the proposed design, MoS$_2$NFs in a metallic phase (1T), which has a large electroactive surface area and abundant active sites, were uniformly decorated with chiral AuNDs through synergistic interactions on screen-printed carbon electrodes. Monoclonal anti-AFP antibodies (mAb) were subsequently immobilized via a carbodiimide-mediated coupling reaction to generate a highly sensitive and specific capture interface (AuNDs@1T-MoS$_2$NFs/mAb/SPCE) towards AFP. The detection mechanism relies on the impediment of electron transfer caused by the formation of an AFP–antibody immunocomplex on the electrode surface, which reduces the redox current of $[Fe(CN)_6]^{3-/4-}$ used as an electrochemical probe. Differential pulse voltammetry (DPV) measurements revealed strong and well-defined redox peaks from the AuNDs@1T-MoS$_2$NFs/mAb interface, which were progressively suppressed with increasing AFP concentrations, indicating the successful formation of the immunocomplex layer on the sensing platform. The developed immunosensor exhibited an impressively low detection limit of 12.4 fg·mL^{-1} and a wide dynamic linearity ranging from 20 fg·mL^{-1} to 1 ng·mL^{-1}. The practical applicability of the developed immunosensor was demonstrated through the selective detection of AFP in human serum samples.