



ISSN: 0167-577X

Materials Letters

An interdisciplinary journal devoted to rapid communications on the science, applications, and processing of materials.

Publishing options: [OA](#) Open Access [S](#) Subscription[Guide for authors](#) [Track your paper](#) [Order journal](#)

Submit your paper



The Impact Factor of this journal is 3.423, ranking it 52 out of 160 in *Physics, Applied*



With this journal indexed in 12 international databases, your published article can be read and cited by researchers worldwide

[View articles](#)**Editor-in-Chief** > [Editorial board](#)

Aldo R. Boccaccini, MSc, Dr.-Ing.
habil.



ScienceDirect

[Journals & Books](#)[Register](#)[Sign in](#)

Materials Letters

Supports open access

5.8

CiteScore

3.423

Impact Factor

[Articles & Issues](#) [About](#) [Publish](#)[Search in this journal](#)[Submit your article](#)[Guide for authors](#)

Volume 259

15 January 2020

[Previous vol/issue](#)[Next vol/issue](#)

materials letters

An interdisciplinary journal devoted to the rapid publication of short communications on the science, applications, and processing of materials.

EDITOR-IN-CHIEF

Aldo R. Boccaccini – Dept. of Materials Science & Engineering, Institute for Biomaterials, Friedrich-Alexander-Universität Erlangen-Nürnberg, Cauerstr. 6, 91058, Erlangen, Germany
(e-mail: aldo.boccaccini@ww.uni-erlangen.de)

EDITORS

R. ARROYAVE – Department of Materials Science and Engineering, Texas A & M University, 119 Mechanical Engineering Office Bldg, College Station, Texas, 77843-3123, USA

M. CARBONI – LHYS Laboratoire des systèmes HYbrides pour la Séparation, Institut de Chimie Séparative de Marcoule, Bât. 426 L1-21 BP 17171, F-30207, Bagnols/Seine cedex, France

R.H.R. CASTRO – Department of Materials Science and Engineering, University of California, Davis, One Shields Ave, Davis, California, 95616, USA

F.L. DE SOUZA – Centro de Ciências Naturais e Humanas, Laboratory of Alternative Energy and Nanomaterials, Federal University of ABC (UFABC), Av. dos Estados, 5001-Santa Terezinha, Santo André, 09210-580, São Paulo, Brazil

O.A. GRAEVE – Dept. of Mechanical and Aerospace Engineering, University of California at San Diego (UCSD), 9500 Gilman Drive, La Jolla, San Diego, California, 92093-0411, USA

J. HOJO – Faculty of Engineering, Kyushu University, 6-1 Kasuga-koen, Kasuga-city, 816-8580, Japan

V.V. KHARTON – Institute of Solid State Physics RAS, 2 Academician Osipyan Str., Chernogolovka, 142432, Moscow District, Russian Federation

I.V. KITIK – Faculty of Electrical Engineering, Inst. of Optoelectronics and Measuring Systems, Politechnika Czeszochowska, ul. Armii Krajowej 17, 42-201, Czeszochowa, Poland

S.E. RODIL – Instituto de Investigaciones en Materiales, Universidad Nacional Autonoma de Mexico, Mexico City, 04510, Coyoacan, Mexico

B. STRAUMAL – Institute of Solid State Physics, Russian Academy of Sciences, Ac. Ossipyan str. 2, 142432, Chernogolovka, Russian Federation

K.G. WEBBER – Department of Materials and Science, FG Glas and Keramik, Friedrich-Alexander-Universität Erlangen-Nürnberg, Martensstr. 5, 91058, Erlangen, Germany

A.F.W. WILLOUGHBY – Engineering Materials, University of Southampton, University Road, SO17 1BJ, Highfield, Southampton, UK

J.-M. YANG – Dept. of Materials Science & Engineering, University of California at Los Angeles (UCLA), Los Angeles, California, CA 90095-1595, USA

Y.F. ZHENG – Department of Materials Science and Engineering, College of Engineering, Peking University, No. 5 Yi-He-Yuan Road, Hai-Dian District, Beijing 100871, China

ASSOCIATE EDITORIAL BOARD

Z. AHMAD, Leicester, UK

K. AIFANTIS, Tucson, USA

A. BELLOSI, Faenza, Italy

J. BLAKER, Manchester, UK

B. BOKSTEIN, Moscow, Russia

M. CINIBULK, Dayton, OH, USA

P. COLOMBO, Padova, Italy

J. DICKERSON, Nashville, TN, USA

N. GAO, University of Southampton, UK

H. GLEITER, Karlsruhe, Germany

A. GLEZER, Russia

T. GOTO, Tohoku, Japan

D.C. GREENSPAN, Alachua, FL, USA

A. HOZUMI, Nagoya, Japan

J. JANG, Taiwan

Y. KAGANOVSKY, Israel

J.A. KILNER, London, UK

M. LANAGAN, University Park, PA, USA

T. LAOUI, Dhahran, Saudi Arabia

X.G. LI, Hefei, China

Y.Y. LI, Hong Kong

T. LOPEZ, Mexico, DF, Mexico

Z.P. LU, Beijing, China

X.L. MA, Shenyang, China

J.F. MANO, Braga, Portugal

V. NOVIKOV, Moscow, Russian Federation

A. ORLOV, New York, USA

P. REED, Southampton, UK

Y. SAKKA, Ibaraki, Japan

M. SAYER, Kingston, Canada

J. SHEN, Chandler, AZ, USA

T. SIEGRIST, Lund, Sweden

N.A. STOLWIJK, Münster, Germany

Y. SUGAHARA, Tokyo, Japan

W.B. WHITE, University Park, PA, USA

Y.F. ZHENG, Beijing, China

C. ZOLLFRANK, Straubing, Germany

Founding Editor: F.F.Y. Wang

Editor Emeritus: J.H. Wernick



ScienceDirect

Materials Letters

Supports *open access*

5.8

CiteScore

3.423

Impact Factor

[Submit your article](#)

[Guide for authors](#)

[Menu](#)



[Search in this journal](#)

Volume 259

15 January 2020

[Download full issue](#)

[Previous vol/issue](#)

[Next vol/issue](#)

Receive an update when the latest issues in this journal are published

[Sign in to set up alerts](#)

Full text access

[Editorial Board](#)

[Article 127036](#)

[Download PDF](#)

Short communication ☐ Abstract only

FEEDBACK

Corrosion of Ti_3SiC_2 ceramics in a high-temperature CO environment

Pavel Istomin, Elena Istomina, Aleksandr Nadutkin, Vladislav Grass

Article 126763

 [Purchase PDF](#) Article preview 

Short communication ☐ Abstract only

Green synthesis of Cu nanoparticles using *Curcuma longa* extract and their application in antimicrobial activity

N. Jayarambabu, A. Akshaykranth, T. Venkatappa Rao, K. Venkateswara Rao, R. Rakesh Kumar

Article 126813

 [Purchase PDF](#) Article preview 

Short communication ☐ Abstract only

Quantum dot scaffold phosphors: Maximizing luminescence quantum yield *via* different stock environments

Mirgender Kumar, Anuj Kumar, Aya Hekmet Makki, Kwang-Su Seong, Si-Hyun Park

Article 126846

 [Purchase PDF](#) Article preview 

Short communication ☐ Abstract only

Strong $\{100\}$ $\langle 012 \rangle$ - $\{411\}$ $\langle 148 \rangle$ recrystallization textures in heavily hot-rolled non-oriented electrical steels

Jing Qin, Jingfu Yang, Yinghui Zhang, Qingyao Zhou, Yanyan Cao

Article 126844

 [Purchase PDF](#) Article preview 

Short communication ☐ Abstract only

Microstructure and corrosion properties of FeCoNiCrMn high entropy alloy coatings prepared by high speed laser cladding and ultrasonic surface mechanical rolling treatment

Zeqin Cui, Zhen Qin, Peng Dong, Yunjun Mi, ... Weiguo Li

Article 126769

 [Purchase PDF](#) Article preview 

Short communication ○ Abstract only

In-situ construction of flower-like BiOBr/BiOCl heterojunctions assembled by thin sheets using an ionic liquid

Cai Yang, Junbo Zhong, Jianzhang Li, Shengtian Huang, Ran Duan

Article 126766

 [Purchase PDF](#) Article preview 

Short communication ○ Abstract only

Freestanding electrically conducting flexible membranes based on novel chitosan/PANI/rGO nanocomposites

N.R. Aswathy, Akshaya K. Palai, S. Mohanty, S.K. Nayak

Article 126777

 [Purchase PDF](#) Article preview 

Short communication ○ Abstract only

Self-assembled protein/carbon nitride/sulfur hydrogel photocatalyst for highly selective solar chemical production

Surabhi Chaubey, Pooja Singh, Chandani Singh, Shambhavi, ... Atul P. Singh

Article 126752

 [Purchase PDF](#) Article preview 

Short communication ○ Abstract only

Substructural phenomena in Cu wire bond after laser assisted manufacturing in electronic packaging

M.Z. Quadir, G. Singh, W.D.A. Rickard, A.S.M.A. Haseeb

Article 126833

 [Purchase PDF](#) Article preview 

Short communication ○ Abstract only

Selective laser melting of CuZr-based metallic glass composites

Xiaodong Gao, Zhaolin Liu, Jianhui Li, Enfu Liu, ... Guang Yang

Article 126724

 [Purchase PDF](#) Article preview 

Short communication ○ Abstract only

Doping and surface passivation improve luminescence intensity and stability of CsPbI₃ nanocrystals for LEDs

Shengnan Liu, Ya Chen, Yi Zhao, Weidong Xiang, Xiaojuan Liang

Article 126857

 [Purchase PDF](#) Article preview 

Short communication ○ Abstract only

Growth of ZnO nanorods on biodegradable poly (lactic acid) (PLA) substrates by low temperature solution method

A. Akshaykranth, T. Venkatappa Rao, R. Rakesh Kumar

Article 126807

 [Purchase PDF](#) Article preview 

Short communication ○ Abstract only

Boron nitride (¹⁰BN) a prospective material for treatment of cancer by boron neutron capture therapy (BNCT)

Manjot Kaur, Paviter Singh, Kulwinder Singh, Usha Singh Gaharwar, ... Akshay Kumar

Article 126832

 [Purchase PDF](#) Article preview 

Short communication ○ Abstract only

Fabrication of nano-TiC reinforced high Nb-TiAl nanocomposites by electron beam melting

W. Kan, B. Chen, H. Peng, Y. Liang, J. Lin

Article 126856

 [Purchase PDF](#) Article preview 

Short communication ○ Abstract only

Synthesis of ZnCo₂O₄ microrods grown on nickel foam for non-enzymatic glucose sensing

Shilin Liu, Wen Zeng, Yanqiong Li

Article 126820

 [Purchase PDF](#) Article preview 

FEEDBACK 

Short communication ○ Abstract only

Effect of indium doping in Nb₂O₅ thin films for electron transport layers: Investigation of structural, optical, and electrical properties

Duanghatai Raknual, Panitee Suttiyakar, Auttasit Tubtimtae, Veeramol Vailikhit

Article 126828

 [Purchase PDF](#) Article preview 

Short communication ○ Abstract only

Three-dimensional porous Sn/NC spheres with outstanding properties for lithium ion battery

Wenyu Wang, Zeru Du, Junchao Qian, Feng Chen

Article 126827

 [Purchase PDF](#) Article preview 

Short communication ○ Abstract only

On a correlation between hydrogen effects on atomic interactions and mobility of grain boundaries in the alpha-iron. Stage II. Mobility of grain boundaries in the H-charged α -iron

S.M. Teus, V.G. Gavriljuk

Article 126859

 [Purchase PDF](#) Article preview 

Short communication ○ Abstract only

Green synthesis of ZnO nanoparticles using whey as an effective chelating agent

V.A. Soares, M.J.S. Xavier, E.S. Rodrigues, C.A. de Oliveira, ... M.S. Silva

Article 126853

 [Purchase PDF](#) Article preview 

Short communication ○ Abstract only

Preparation and characterization of press-formed fly ash cement incorporating soda residue

Xianhui Zhao, Chunyuan Liu, Liming Zuo, Qin Zhu, ... Youcai Liu

Article 126852

[Purchase PDF](#) Article preview 

Short communication ☐ Abstract only

In situ multi-field investigation of grain size effects on the rate-dependent thermomechanical responses of polycrystalline superelastic NiTi

Junyu Chen, Yupeng Wu, Hao Yin

Article 126845

[Purchase PDF](#) Article preview 

Short communication ☐ Abstract only

BiVO₄-nanorod-decorated rutile/anatase TiO₂ nanofibers with enhanced photoelectrochemical performance

Chaoqun Ma, Mingzhi Wei

Article 126849

[Purchase PDF](#) Article preview 

Short communication ☐ Abstract only

Efficient degradation of methylene blue by Co(II) complexes constrained to the wall of mesoporous silica decorated by Pt nanoparticles

Maryam Ghazvini, Abdolghafar Abolhosseini Shahrnoy

Article 126776

[Purchase PDF](#) Article preview 

Short communication ☐ Abstract only

A comparative study on the influences of CNT and GNP on the piezoresistivity of cement composites

Jin Tao, Jiyang Wang, Qiang Zeng

Article 126858

[Purchase PDF](#) Article preview 

Short communication ☐ Abstract only

Effect of growth temperature on the microstructural properties of 0.95Na_{0.5}Bi_{0.5}TiO₃–0.05BaTiO₃ films prepared on MgO (001) substrates

FEEDBACK 

Sheng-Qiang Wu, Yi-Yang Yun, Xiao-Wei Jin, Sheng Cheng, ... Shao-Bo Mi

Article 126847

 [Purchase PDF](#) Article preview 

Short communication ○ Abstract only

A ternary composite RuO₂@SWCNT/graphene for high performance electrochemical capacitors

Li Yang, Jianmin Zhang, Yuansai Zhang, Yuling Zhao, ... Jie Tang

Article 126860

 [Purchase PDF](#) Article preview 

Short communication ○ Abstract only

Visualization of magnetic domain structure in FeSi based high permeability steel plates by neutron imaging

I. Dhiman, R. Ziesche, L. Riik, I. Manke, ... N. Kardjilov

Article 126816

 [Purchase PDF](#) Article preview 

Short communication ○ Abstract only

Laser cladding and *in-situ* nitriding of martensitic stainless steel coating with striking performance

Baichun Li, Hongmei Zhu, Changjun Qiu, Xiaokang Gong

Article 126829

 [Purchase PDF](#) Article preview 

Short communication ○ Abstract only

Microstructure and mechanical properties of AA6061 alloy deformed by differential speed rolling

Young Gun Ko, Umer Masood Chaudry, Kotiba Hamad

Article 126870

 [Purchase PDF](#) Article preview 

Short communication ○ Abstract only

FEEDBACK 

Fabrication, microstructure and mechanical properties of Al₂O₃ whiskers reinforced Ti-46Al-4Nb alloy

Sen Cui, Chunxiang Cui, Jian Lv, Siyi Chen, ... Shuangjin Liu

Article 126902

 [Purchase PDF](#) Article preview 

Short communication ○ Abstract only

Effect of boundaries on toughness in high-strength low-alloy steels from the view of crystallographic misorientation

Xiucheng Li, Jingxiao Zhao, Jingliang Wang, Xuelin Wang, ... Chengjia Shang

Article 126841

 [Purchase PDF](#) Article preview 

Short communication ○ Abstract only

Microstructural evolution and dimensional stability of TiC-reinforced steel matrix composite during tempering

L.R. Xiao, X.X. Tu, X.J. Zhao, Z.Y. Cai, Y.F. Song

Article 126871

 [Purchase PDF](#) Article preview 

Short communication ○ Abstract only

Effect and study of reducing agent NaBH₄ on Bi/BiOBr/CdS photocatalyst

Zhanyao Gao, Binghua Yao, Tiantian Xu, Minmin Ma

Article 126874

 [Purchase PDF](#) Article preview 

Short communication ○ Abstract only

Self-propagating rapid synthesis and characterization of LaCrO₃ powder

Dayan Xie, Kuibao Zhang, Weiwei Li, Baozhu Luo, Haibin Zhang

Article 126873

 [Purchase PDF](#) Article preview 

Short communication ○ Abstract only

Determination of the creep function using atomic force microscope

Alexander P. Kren, Alexander S. Machikhin, Marat F. Bulatov

Article 126872

 [Purchase PDF](#) Article preview 

Short communication ○ Abstract only

Polyvinylidene fluoride aerogel with high thermal stability and low thermal conductivity

Jiayue Zhang, Yong Kong, Xiaodong Shen

Article 126890

 [Purchase PDF](#) Article preview 

Short communication ○ Abstract only

Research on the composite curling characteristic of plastic film reinforced pliable veneer of teak

Xiaorui Peng, Zhankuan Zhang

Article 126850

 [Purchase PDF](#) Article preview 

Short communication ○ Abstract only

Formaldehyde sensing characteristics of hydrothermally synthesized Zn_2SnO_4 nanocubes

Y. Tie, S.Y. Ma, S.T. Pei, K.M. Zhu, ... Y. Ma

Article 126896

 [Purchase PDF](#) Article preview 

Short communication ○ Abstract only

Synthesis and optical properties of blue pigment CoAl_2O_4 nanofibers by electrospinning

Romteera Chueachot, Ronariddh Nakhowong

Article 126904

 [Purchase PDF](#) Article preview 

Short communication ○ Abstract only

Effect of interconnect coating procedure on solid oxide fuel cell performance

Hamid Abdoli, Sebastian Molin, Hamidreza Farnoush

Article 126898

[Purchase PDF](#) [Article preview](#) 

Short communication ☐ Abstract only

The surface modification of Ag_3PO_4 using anionic platinum complexes for enhanced visible-light photocatalytic activity

Uyi Sulaeman, Richo Dwi Permadi, Dian Riana Ningsih, Hartiwi Diastuti, ... Shu Yin

Article 126848

[Purchase PDF](#) [Article preview](#) 

Short communication ☐ Abstract only

Zi-Ran-Tong loaded brushite bone cement with enhanced osteoblast mineralization ability in vitro

Zhengjun Pei, Kaili Zhang, Pengbin Li, Jiangbo Zhai, ... Wenchao Shang

Article 126908

[Purchase PDF](#) [Article preview](#) 

Short communication ☐ Abstract only

One-pot hydrothermal synthesis of three-dimensional flower-like hollow Bi_2WO_6 /reduced graphene oxide hybrid for sensitive photoelectrochemical detection of diethylstilbestrol

Chaoyue Cai, Cheng Wang, Chengyan Zhang, Qian Guo, ... Mingyan Wang

Article 126851

[Purchase PDF](#) [Article preview](#) 

Short communication ☐ Abstract only

Thiolated gellan gum hydrogels as a peptide delivery system for 3D neural stem cell culture

Yue Yu, Shanshan Zhu, Dongwei Wu, Lihua Li, ... Lu Lu

Article 126891

[Purchase PDF](#) [Article preview](#) 

Short communication ☐ Abstract only

Effect of cold rolling on the microstructure and texture evolution of as-cast

(Ti₅₅Zr₂₅Nb₁₀Ta₁₀)_{99.5}-Fe_{0.5} alloy

Amir Zareidoost, Mardali Yousefpour

Article 126876

 [Purchase PDF](#) Article preview 

Short communication ☐ Abstract only

Improved energy storage properties of Mn and Y co-doped BST films

Zunping Xu, Hua Qiang, Yi Chen

Article 126894

 [Purchase PDF](#) Article preview 

Short communication ☐ Abstract only

Degradability and *in vivo* biocompatibility of doped magnesium phosphate bioceramic scaffolds

Kaushik Sarkar, Mofizur Rahaman, Swarnima Agarwal, Subhadip Bodhak, ... Mangal Roy

Article 126892

 [Purchase PDF](#) Article preview 

Short communication ☐ Abstract only

Facile synthesis of silver nanoparticles with medicinal grass and its biological assessment

Satheeshkumar Balu, Swetha Andra, Saranya Kannan, Manisha Vidyavathy S, Murugesan Muthalagu

Article 126900

 [Purchase PDF](#) Article preview 

Short communication ☐ Abstract only

Suppressing interfacial voids in Cu/In/Cu microbump with Sn and Cu addition

Rui-Wen Song, Collin Jordon Fleshman, Hao Chen, Su-Yueh Tsai, Jenq-Gong Duh

Article 126855

 [Purchase PDF](#) Article preview 

Short communication ☐ Abstract only

Laser powder bed fusion of a Zr-alloy: Tensile properties and biocompatibility

FEEDBACK 

M. Aristizabal, P. Jamshidi, A. Saboori, S.C. Cox, M.M. Attallah

Article 126897

 [Purchase PDF](#) Article preview 

Short communication ○ Abstract only

The synthesis of hydroxyapatite crystals with various morphologies via the solvothermal method using double surfactants

Rigui Chen, Juan Shen

Article 126881

 [Purchase PDF](#) Article preview 

Short communication ○ Abstract only

CVD grown defect rich-MWCNTs with anchored CoFe alloy nanoparticles for OER activity

Zulfiqar Ali, Mazhar Mehmood, Jamil Ahmed, Abdul Majeed, Khalid Hussain Thebo

Article 126831

 [Purchase PDF](#) Article preview 

Short communication ○ Abstract only

Inverse vulcanized sulfur–cycloalkene copolymers: Effect of ring size and unsaturation on thermal properties

Meera Y. Omeir, Vijay S. Wadi, Saeed M. Alhassan

Article 126887

 [Purchase PDF](#) Article preview 

Short communication ○ Abstract only

A novel hot-pressing method to prepare foamable precursor of aluminum foam sandwich (AFS)

Xiang Ding, Yuan Liu, Tan Wan

Article 126895

 [Purchase PDF](#) Article preview 

Short communication ○ Abstract only

Strain induced martensite stabilization in β Ti-Zr-Nb shape memory alloy

FEEDBACK 

Xiaoyun Song, Chengyang Xiong, Fei Zhang, Yongsheng Nie, Yan Li
Article 126914

[↓ Purchase PDF](#) [Article preview](#) 

[< Previous vol/issue](#)

[Next vol/issue >](#)

ISSN: 0167-577X

Copyright © 2022 Elsevier B.V. All rights reserved



Copyright © 2022 Elsevier B.V. or its licensors or contributors.
ScienceDirect® is a registered trademark of Elsevier B.V.

RELX™

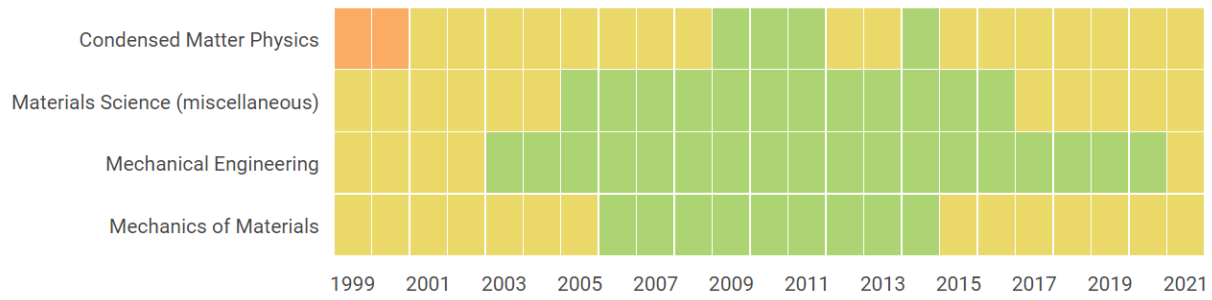
FEEDBACK 

Materials Letters

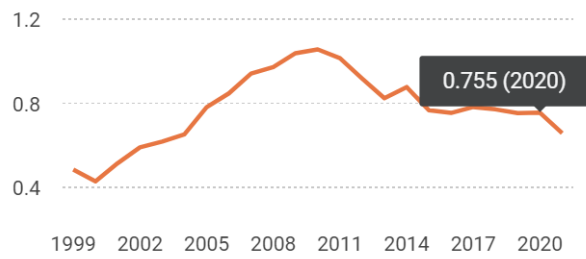
COUNTRY Netherlands  Universities and research institutions in Netherlands	SUBJECT AREA AND CATEGORY Engineering Mechanical Engineering Mechanics of Materials Materials Science Materials Science (miscellaneous) Physics and Astronomy Condensed Matter Physics	PUBLISHER Elsevier
H-INDEX 155	PUBLICATION TYPE Journals	ISSN 0167577X
COVERAGE 1982-2022	INFORMATION Homepage How to publish in this journal matlet@elsevier.com	
SCOPE		

Materials Letters has an open access mirror journal Materials Letters: X, sharing the same aims and scope, editorial team, submission system and rigorous peer review. Materials Letters is dedicated to publishing novel, cutting edge reports of broad interest to the materials community. The journal provides a forum for materials scientists and engineers, physicists, and chemists to rapidly communicate on the most important topics in the field of materials. Contributions include, but are not limited to, a variety of topics such as: • Materials - Metals and alloys, amorphous solids, ceramics, composites, polymers, semiconductors • Applications - Structural, opto-electronic, magnetic, medical, MEMS, sensors, smart • Characterization - Analytical, microscopy, scanning probes, nanoscopic, optical, electrical, magnetic, acoustic, spectroscopic, diffraction • Novel Materials - Micro and nanostructures (nanowires, nanotubes, nanoparticles), nanocomposites, thin films, superlattices, quantum dots. • Processing - Crystal growth, thin film processing, sol-gel processing, mechanical processing, assembly, nanocrystalline processing. • Properties - Mechanical, magnetic, optical, electrical, ferroelectric, thermal, interfacial, transport, thermodynamic • Synthesis - Quenching, solid state, solidification, solution synthesis, vapor deposition, high pressure, explosive

Quartiles



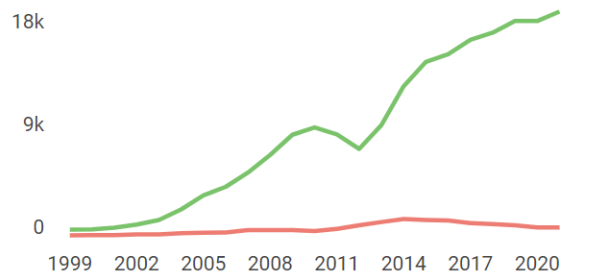
SJR



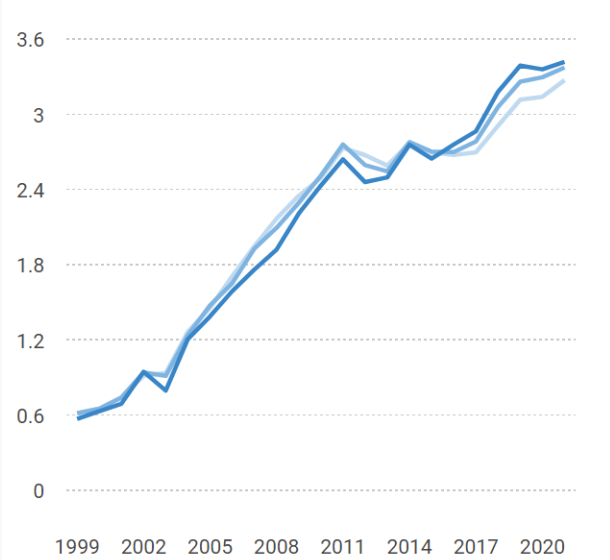
Total Documents



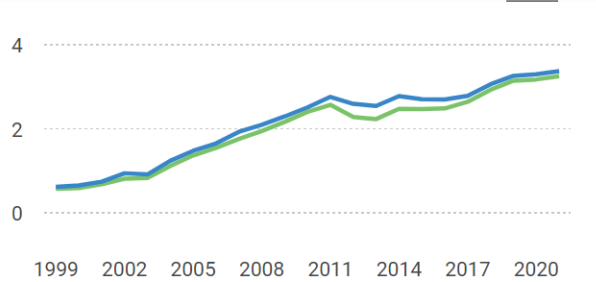
Total Cites Self-Cites



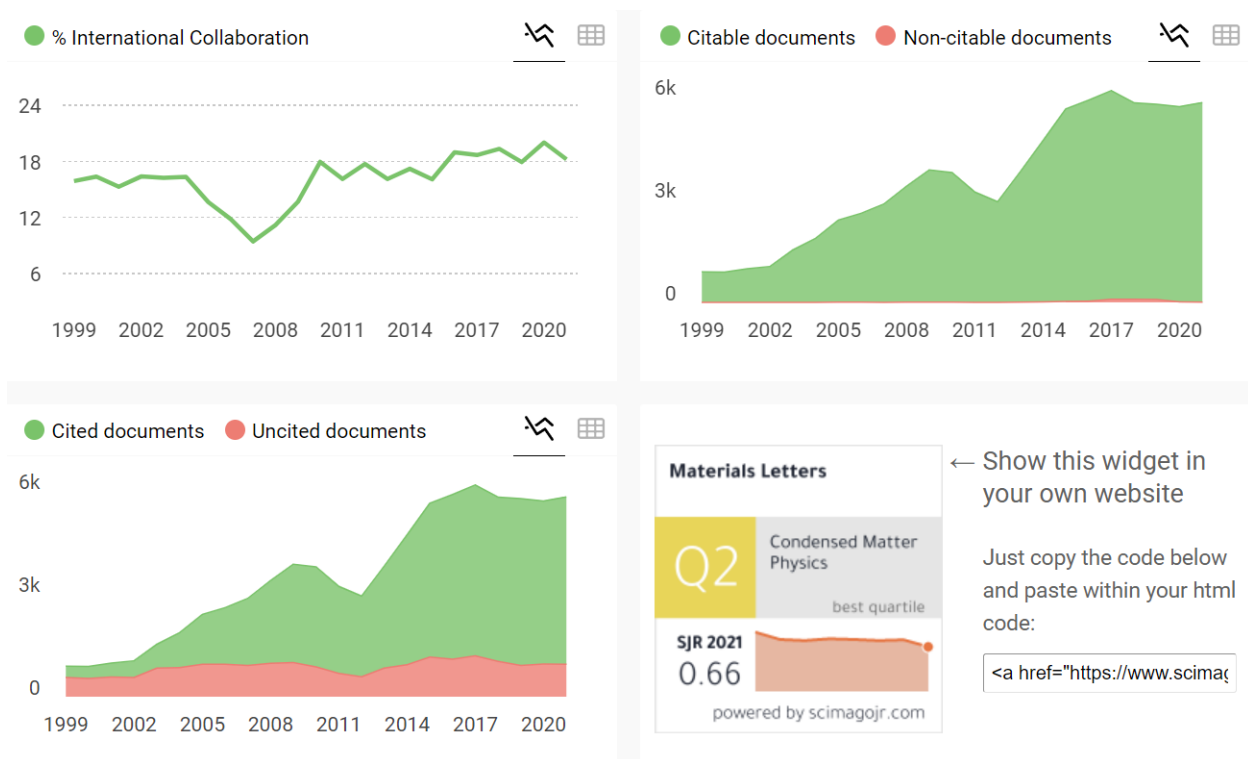
Citations per document



External Cites per Doc Cites per Doc



- Cites / Doc. (4 years)
- Cites / Doc. (3 years)
- Cites / Doc. (2 years)



Master Journal List

[Search Journals](#)
[Match Manuscript](#)
[Downloads](#)
[Help Center](#)

[Login](#)
[Create Free Account](#)

The power of the Web of Science™ on your mobile device, wherever inspiration strikes.

Dismiss

Learn More

MATERIALS LETTERS

Publisher: ELSEVIER, RADARWEG 29a, AMSTERDAM, Netherlands, 1043 NX

ISSN / eISSN: 0167-577X / 1873-4979

Web of Science Core Collection: Science Citation Index Expanded

Additional Web of Science Indexes: Current Contents Engineering, Computing & Technology | Current Contents Physical, Chemical & Earth Sciences | Essential Science Indicators

[Share This Journal](#)

[View profile page](#)

* Requires free login.



The surface modification of Ag_3PO_4 using anionic platinum complexes for enhanced visible-light photocatalytic activity



Uyi Sulaeman^{a,*}, Richo Dwi Permadi^a, Dian Riana Ningsih^a, Hartiwi Diastuti^a, Anung Riapanitra^{a,b}, Shu Yin^b

^a Department of Chemistry, Jenderal Soedirman University, Purwokerto 53123, Indonesia

^b Institute of Multidisciplinary Research for Advanced Materials, Tohoku University, Sendai 980-8577, Japan

ARTICLE INFO

Article history:

Received 10 August 2019

Received in revised form 18 October 2019

Accepted 20 October 2019

Available online 21 October 2019

Keywords:

Anionic platinum complexes

Defect

Photocatalyst

Silver phosphate

Silver vacancy

ABSTRACT

The surface modification of Ag_3PO_4 using anionic platinum complexes was successfully prepared. The starting materials of chloroplatinic chloride hydrate, silver nitrate, and sodium dihydrogen phosphate dodecahydrate were used in the experiments. The Ag_3PO_4 (AP) and defect- Ag_3PO_4 (DAP) were firstly synthesized using the coprecipitation method. These samples were suspended in chloroplatinic chloride solution under sonication to obtain the doping of anionic platinum complexes in Ag_3PO_4 (AP/Pt) and defect- Ag_3PO_4 (DAP/Pt). Anionic platinum complexes successfully substituted the phosphate site of Ag_3PO_4 and significantly improved the photocatalytic activity.

© 2019 Elsevier B.V. All rights reserved.

1. Introduction

Utilizing platinum as a dopant has been widely used to improve the catalytic activity of photocatalyst. Many types of platinum can be incorporated into photocatalyst. The most common type is the metallic Pt nanoparticles, as utilized for TiO_2 photocatalyst modifications [1,2]. Other types are platinum ion, complex-ion, and cluster ion. The Pt ions doping into the lattice of TiO_2 is supported by the similar ionic radii of Pt^{4+} and Ti^{4+} [3]. The combination of Pt^{2+} ion and metallic Pt can also be applied to enhance catalytic activity of $\alpha\text{-Fe}_2\text{O}_3$ [4]. The Pt^{2+} in $\alpha\text{-Fe}_2\text{O}_3$ increases the isolation efficiency of the photo-induced carriers that improve the lifespan of hole carriers, whereas the metallic Pt in $\alpha\text{-Fe}_2\text{O}_3$ brought to the generation of Schottky barriers. TiO_2 surface modification using the clusters ion of $[\text{Pt}_3(\text{CO})_6]^{2-}$ also improves the catalytic activity [5]. Platinum clusters act as charge scavenger that inhibits charge recombination and also act as a sensitizer.

Herein, the anionic platinum complexes doping in Ag_3PO_4 was successfully synthesized. Anionic platinum complexes successfully substitute the phosphate ion of Ag_3PO_4 under sonication. The substitution effectively occurs on the silver vacancy of Ag_3PO_4 . Up to now, there is no report of incorporating the Ag_3PO_4 by platinum complexes, and the result is very significant for the improvement

of Ag_3PO_4 -based photocatalyst. The rate of catalytic increased up to 5.8 times higher compared to the pure Ag_3PO_4 . The RhB can be degraded to 99.36% for only 6 min under the blue LED irradiation of 3 W.

2. Experimental

The Ag_3PO_4 and defect- Ag_3PO_4 were prepared using the co-precipitation method based on the previous results [6]. To prepare the defect- Ag_3PO_4 , the starting material of AgNO_3 (0.85 g) and $\text{Na}_2\text{HPO}_4 \cdot 12\text{H}_2\text{O}$ (1.79 g) were dissolved in 200 mL of ethanol-water (50% ethanol) and 50 mL of water, respectively. The Na_2HPO_4 aqueous solution was slowly added to AgNO_3 ethanol-aqueous solution. The precipitates in this reaction were filtered and washed with distilled water and subsequently dried in an oven at 60 °C for 4 h. The Ag_3PO_4 (defect-free sample) as a control was prepared similar to the defect- Ag_3PO_4 preparation but using only 200 mL of water to dissolve the starting material of AgNO_3 , without addition of ethanol. To incorporate the anionic platinum complexes, the Ag_3PO_4 and defect- Ag_3PO_4 (0.5 g) was suspended in 10 mL of water under sonication. An amount of 10 mL of Pt solution was added to the suspension. The mixtures were sonicated for 5 min and mixed under magnetic stirrer for 30 min. The solution of chloroplatinic acid ($\text{H}_2\text{PtCl}_6 \cdot 6\text{H}_2\text{O}$) in water were designed at a concentration of 1.33 mg/mL. The obtained precipitates were filtered and washed with water three times and dried in an oven at

* Corresponding author.

E-mail address: sulaeman@unsoed.ac.id (U. Sulaeman).

60 °C for 4 h. The samples of Ag_3PO_4 , defect- Ag_3PO_4 , $\text{Ag}_3\text{PO}_4/\text{PtCl}_6^{2-}$ and defect- $\text{Ag}_3\text{PO}_4/\text{PtCl}_6^{2-}$ were named as AP, DAP, AP/Pt, and DAP/Pt, respectively.

The structure and bandgap energy were investigated using the XRD (Bruker AXS D2 PHASER) and DRS (Shimadzu, UV-2450), respectively. The binding energy and atomic composition were analyzed using XPS (Perkin Elmer PHI 5600).

To investigate the catalytic activities, 0.1 g of catalysts was contacted to RhB solution (100 mL, 10 mg/L) and equilibrated in a dark room [7]. The photocatalytic test was carried out under the visible light irradiation (Blue LED, 3 Watt). During the photocatalytic reaction, the RhB concentration was measured by the spectrophotometer (Shimadzu 1800).

3. Results and discussion

Fig. 1 shows the XRD pattern of Ag_3PO_4 (AP), defect- Ag_3PO_4 (DAP), $\text{Ag}_3\text{PO}_4/\text{PtCl}_6^{2-}$ (AP/Pt) and defect- $\text{Ag}_3\text{PO}_4/\text{PtCl}_6^{2-}$ (DAP/Pt). All of the samples exhibited a structure of body-centered-cubic (JCPDS No.06-0505) [8]. A little shift and doublet of the XRD pattern might be due to the effect of PtCl_6^{2-} incorporation.

The absorption of samples is presented in Fig. 2, and the bandgap energies were determined by the following formula (1):

$$(Ah\nu)^2 = h\nu - E_g \quad (1)$$

where A, h, ν , and E_g were absorbance, Planck constant, light frequency and bandgap energy [9]. The calculations derived from the DRS data are shown in Fig. S1 (Supplementary Material), the bandgap energy of 2.40 eV, 2.41 eV, 2.44 eV, and 2.44 eV were gained for AP, DAP, AP/Pt and DAP/Pt, respectively. The slight blue shift occurred in AP/Pt, and DAP/Pt might be caused by a chemically bonding of anionic platinum complexes on the surface of Ag_3PO_4 .

Based on XPS analysis, the spectra of Pt in AP/Pt and DAP/Pt were observed (Fig. 3). The content of 2.94% and 3.41% of Pt existed in AP/Pt and DAP/Pt, respectively. The higher content of Pt in DAP/Pt might be induced by the silver vacancy sites of DAP. The binding energies (BEs) of 73.18 eV and 75.12 eV were assigned to $\text{Pt(II)}_{4f_{7/2}}$ and $\text{Pt(IV)}_{4f_{7/2}}$ of AP/Pt, respectively whereas the BEs of 73.06 eV and 74.99 eV were assigned to $\text{Pt(II)}_{4f_{7/2}}$ and $\text{Pt(IV)}_{4f_{7/2}}$ of DAP/Pt, respectively [10]. The decreased BE of DAP/Pt might be the effect of defect changes from the silver deficiency to the phosphor deficiency. The concentration of Pt(IV) was higher than those in both AP/Pt and DAP/Pt. There was no metallic Pt state found in Ag_3PO_4 . The state of Pt(II) might be originated from the

reduction of Pt(IV) that might be reduced by an electron from the hydroxyl group [11].

The atomic ratios of Ag/P and P/O in the sample AP, DAP, AP/Pt, and DAP/Pt were calculated from the XPS data. The Ag/P atomic ratio of DAP (2.49) was lower than that of AP (2.80), implying that the DAP contained silver vacancy defect sites. After anionic platinum complexes doping, the Ag/P atomic ratio in AP/Pt was slightly increased (2.81), on the opposite, it was significantly increased in DAP/Pt (2.97). This result indicated that the elimination of phosphate ion might occur. This phenomenon was also convinced by the decrease of phosphor concentration after Pt complexes ion doping. The phosphor contents were 10.9%, 11.5%, 9.0%, and 8.1% in AP, DAP, AP/Pt, and DAP/Pt, respectively. The decreased phosphor in AP/Pt and DAP/Pt might be caused by substituting platinum complexes ion. The lowest content of phosphor in DAP/Pt implying that the silver vacancy was no longer existed in DAP and changed into a phosphor deficiency. The P/O atomic ratios of 0.26, 0.26, 0.22 and 0.20 were observed in AP, DAP, AP/Pt, and

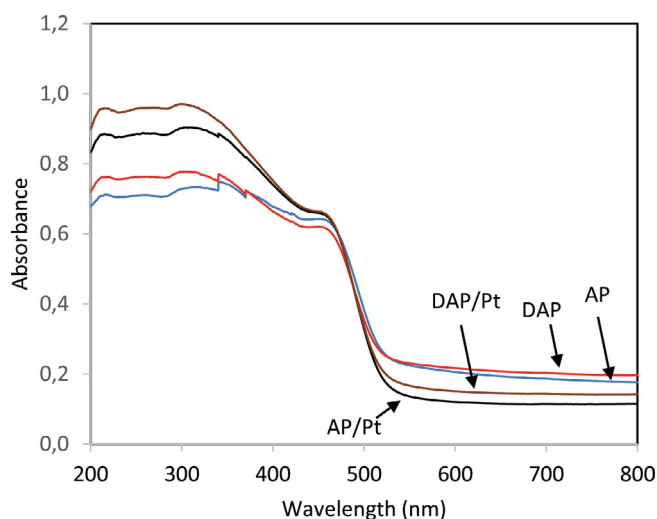


Fig. 2. The absorption of Ag_3PO_4 (AP), defect- Ag_3PO_4 (DAP), $\text{Ag}_3\text{PO}_4/\text{PtCl}_6^{2-}$ (AP/Pt), and defect- $\text{Ag}_3\text{PO}_4/\text{PtCl}_6^{2-}$ (DAP/Pt).

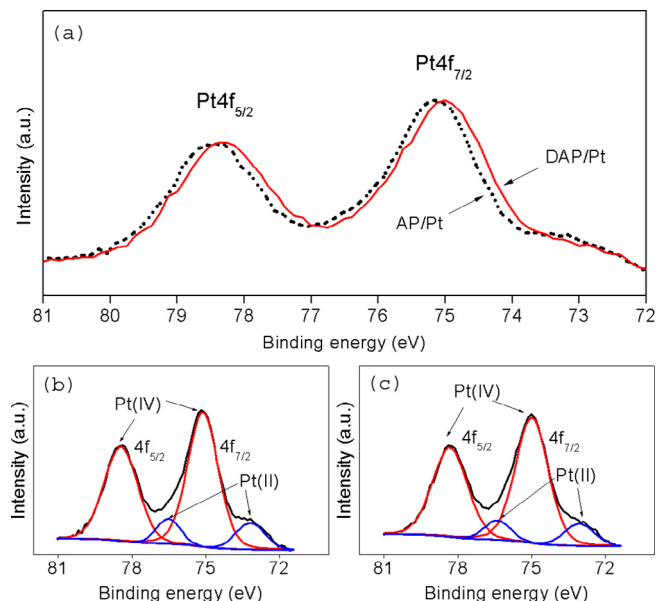


Fig. 3. The XPS profile of Pt4f in AP/Pt and DAP/Pt (a) and the deconvolution of AP/Pt (b) and DAP/Pt (c).

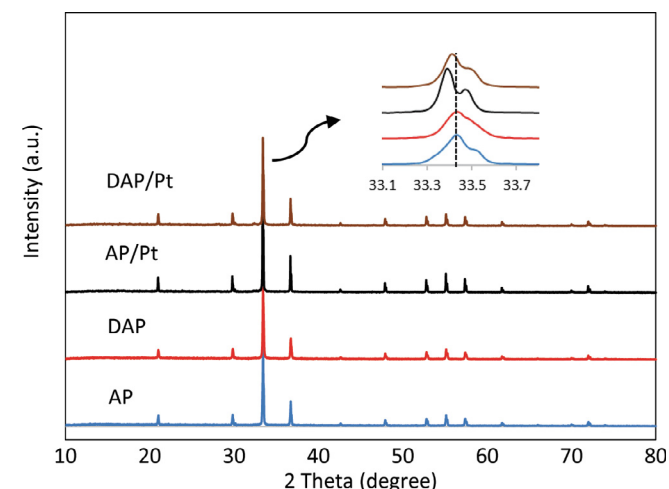


Fig. 1. The XRD pattern of Ag_3PO_4 (AP), defect- Ag_3PO_4 (DAP), $\text{Ag}_3\text{PO}_4/\text{PtCl}_6^{2-}$ (AP/Pt), and defect- $\text{Ag}_3\text{PO}_4/\text{PtCl}_6^{2-}$ (DAP/Pt).

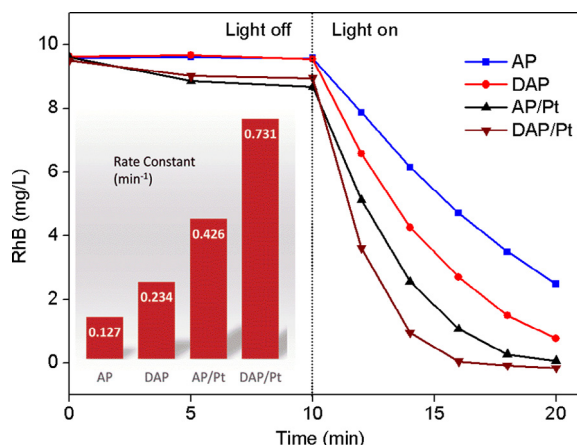


Fig. 4. Photocatalytic activity of Ag_3PO_4 (AP), defect- Ag_3PO_4 (DAP), $\text{Ag}_3\text{PO}_4/\text{PtCl}_6^{2-}$ (AP/Pt), and defect- $\text{Ag}_3\text{PO}_4/\text{PtCl}_6^{2-}$ (DAP/Pt).

DAP/Pt, respectively. The lowest P/O atomic ratio of DAP/Pt proved phosphor deficiency.

Fig. 4 shows the photocatalytic activity under blue light irradiation. The percentage of RhB removal efficiency (η in %) was calculated by the following equation (2).

$$\eta = \left(\frac{C_0 - C}{C_0} \times 100 \right) \% \quad (2)$$

where C_0 and C are the concentration at the starting time and after some time t of photocatalytic reaction, respectively [12]. The degradation percentage of 50.80%, 71.93%, 88.77%, and 99.38% has been achieved after 6 min irradiation for the samples of AP, DAP, AP/Pt, and DAP/Pt, respectively. The rates of photocatalytic reaction were also calculated using the pseudo-first-orders kinetic [12], the results showed the rate constant of 0.127 min^{-1} , 0.234 min^{-1} , 0.426 min^{-1} , and 0.731 min^{-1} for AP, DAP, AP/Pt, and DAP/Pt, respectively. The sample of DAP/Pt possessed the highest catalytic activity. The catalytic rate enhanced significantly up to 5.8 times higher compared to the pure Ag_3PO_4 , and RhB completely degraded after 6 min. This result was even higher compared to other works utilized the CNT to modify Ag_3PO_4 , in which RhB dye was degraded after 12 min [9].

The silver vacancy in DAP had a significant effect on photocatalytic activity. It could trap the photogenerated electron-hole and prolongs the lifespan of photoexcited electron-hole pairs. The samples of AP and DAP treated under PtCl_6^{2-} solution resulted in AP/Pt and DAP/Pt samples, respectively. These samples exhibited higher catalytic activity with DAP/Pt showed the highest activity compared to AP and DAP, suggesting that the silver vacancy may enhance the incorporation of Pt complexes and changed it into a phosphor deficient.

The Pt complexes could be the main factor in the improvement of catalytic activity by capturing the photogenerated electron and inhibiting the electron-hole recombination. The enhanced activity

was due to efficient electron transfer between the Ag_3PO_4 conduction band and the chemically bonding of Pt(IV) species, which brought to efficient charge separation, similar to that of PtCl_4 -modified TiO_2 [13].

4. Conclusion

Anionic platinum complexes successfully substitute the phosphate ion of Ag_3PO_4 . The anionic platinum complexes incorporation in Ag_3PO_4 significantly improved the catalytic activity of Ag_3PO_4 . The excellent photocatalytic activity was ascribed to efficient electron transfer between the Ag_3PO_4 conduction band and the chemically bonding of platinum complexes brought to efficient charge separation.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgements

This research was supported by the Ministry of Research, Technology and Higher Education of the Republic of Indonesia in the Scheme of Basic Research, 176/SP2H/LT/DRPM/2019. It was also partly supported by the JSPS KAKENHI Grant Number JP16H06439 and the Cooperative Research Program of "Network Joint Research Center for Materials and Devices"

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.matlet.2019.126848>.

References

- [1] X. Pan, X. Chen, Z. Yi, A.C.S. Appl. Mater. Interfaces 8 (2016) 10104–10108.
- [2] E. Antolini, Appl. Catal. B Environ. 237 (2018) 491–503.
- [3] M. Tasbihi, K. Kočí, M. Edelmánová, I. Troppová, M. Reli, R. Schomäcker, J. Photochem. Photobiol. A Chem. 366 (2018) 72–80.
- [4] H. Liu, K. Tian, J. Ning, Y. Zhong, Z. Zhang, Y. Hu, ACS Catal. 9 (2019) 1211–1219.
- [5] E. Kowalska, H. Remita, C. Colbeau-Justin, J. Hupka, J. Belloni, J. Phys. Chem. C 112 (2008) 1124–1131.
- [6] U. Sulaeman, D. Hermawana, R. Andreas, A.Z. Abdullah, S. Yin, Appl. Surf. Sci. 428 (2018) 1029–1035.
- [7] U. Sulaeman, S. Suhendar, H. Diastuti, A. Riapanitra, S. Yin, Solid. State Sci. 86 (2018) 1–5.
- [8] J. Deng, L. Liu, T. Niu, X. Sun, Appl. Surf. Sci. 403 (2017) 531–539.
- [9] H. Xu, C. Wang, Y. Song, J. Zhu, Y. Xu, J. Yan, Y. Song, H. Li, Chem. Eng. J. 241 (2014) 35–42.
- [10] A. Romanchenko, M. Likhatski, Y. Mikhlin, Minerals 8 (2018) 578.
- [11] B. Zhang, B. Shen, M. Guo, Y. Liu, Aust. J. Chem. 71 (12) (2018) 931–938.
- [12] P. Kumbhakar, A. Pramanik, S. Biswas, A.K. Kole, R. Sarkar, P. Kumbhakar, J. Hazard. Mater. 360 (2018) 193–203.
- [13] W. Zhao, C. Chen, W. Ma, J. Zhao, D. Wang, H. Hidaka, N. Serpone, Chem. Eur. J. 9 (2003) 3292–3299.