



Volume 72
Issue 1
March 2015
Pages 1-48

Published since 1978
formerly as Archives of Materials Science
or Archiwum Nauki o Materiałach (in Polish)

Archives of Materials Science and Engineering



Editor-in-Chief Prof. Leszek A. Dobrzański

International Scientific Journal published monthly
by the World Academy of Materials
and Manufacturing Engineering

<http://www.archivesmse.org>



PUBLISHED SINCE 1978 – formerly as Archives of Materials Science or Archiwum Nauki o Materiałach (in Polish)

Editor-in-Chief

Prof. Leszek A. Dobrzański – Gliwice, POLAND

Editorial Council

DEPUTIES EDITOR-IN-CHIEF

Prof. Gilmar Batalha – Sao Paulo, BRASIL
Prof. Anna Dobrzańska-Danikiewicz – Gliwice, POLAND
Prof. Nikolaos Gouskos – Athens, GREECE
Prof. Toshio Haga – Osaka, JAPAN
Prof. Abdel Magid Hamouda – Doha, QATAR
Prof. Mark J. Jackson – Worcester, USA
Prof. Thomas Neitzert – Auckland, NEW ZELAND
Prof. Jerzy Nowacki – Szczecin, POLAND
Prof. Ming-Jen Tan – Singapore, SINGAPORE

PRODUCTION EDITOR

Ms Marzena Kraszewska, MA – Gliwice, POLAND

Associated Editors

THEMATIC AREA EDITORS

Prof. Grzegorz Chladek – Gliwice, POLAND
Prof. Klaudiusz Gołombek – Gliwice, POLAND
Prof. Krzysztof Lukaszewicz – Gliwice, POLAND
Prof. Wojciech Sitek – Gliwice, POLAND
Dr Mirosław Bonek – Gliwice, POLAND

STATISTICAL EDITOR

Prof. Marcin Adamiak – Gliwice, POLAND

LANGUAGE EDITOR

Prof. Piotr Malara – Gliwice, POLAND

TECHNICAL EDITOR

Dr Małgorzata Dziekońska – Gliwice, POLAND

TEXT EDITORS

Dr Eugeniusz Hajduczek – Gliwice, POLAND
Ms Justyna Hajduczek-Jarka, MSc – Gliwice, POLAND

READING DIRECT EDITORS

Dr Marek Sroka – Gliwice, POLAND
Mr Adam Jagiełło, MSc – Gliwice, POLAND

Editorial Assistance

Ms Magdalena Macek, MSc – Gliwice, POLAND
Ms Barbara Nieradka, MSc – Gliwice, POLAND
Ms Marzena Prokopiuk vel Prokopowicz, MSc – Gliwice, POLAND

Editorial Key Reviewers Committee

Prof. Sadek Absi-Alfaro – Brasilia, BRAZIL
Prof. Dorel Banabic – Cluj Napoca, ROMANIA
Prof. Tadeusz Bold – Gliwice, POLAND
Prof. Tara Chandra – Wollongong, AUSTRALIA
Prof. Antonio Cunha – Guimaraes, PORTUGAL
Prof. Jan Cwajna – Katowice, POLAND
Prof. Elena David – Rm.Valcea, ROMANIA
Prof. Tsanka Dikova – Varna, BULGARIA
Prof. Janusz Dobrzański – Gliwice, POLAND
Prof. Edward D. Doyle – Swinburne, AUSTRALIA
Prof. Georgiy Drapak – Khmelnytsky, UKRAINE
Prof. Jan Dutkiewicz – Cracow, POLAND
Prof. Jan Džugan – Dobrony, CZECH REPUBLIC
Prof. Stuart Hampshire – Limerick, IRELAND
Prof. Adam Hernas – Katowice, POLAND
Prof. Marek Hetmańczyk – Katowice, POLAND
Prof. Hong Hocheng – Hsinchu, TAIWAN
Prof. David Hui – New Orleans, USA
Prof. Yong-Taek Im – Daejeon, KOREA
Prof. Leopold Jeziorski Dr hc – Czestochowa, POLAND
Prof. Jan Kazior – Cracow, POLAND
Prof. Il-Soo Kim – Daejeon, KOREA
Prof. Albert Kneissl – Leoben, AUSTRIA
Prof. Ivars Knets – Riga, LATVIA
Prof. Janez Kopač Dr hc – Ljubljana, SLOVENIA
Prof. Antonin Kriz – Plzen, CZECH REPUBLIC
Prof. Lothar Kroll – Chemnitz, GERMANY
Prof. Piotr Kula – Lodz, POLAND
Prof. Krzysztof J. Kurzydłowski Dr hc – Warsaw, POLAND
Prof. Karl Kuzman – Ljubljana, SLOVENIA
Prof. Klaudiusz Lenik – Lublin, POLAND
Prof. Eugeniusz Łągiewka – Katowice, POLAND
Prof. Bogusław Major – Cracow, POLAND
Prof. Cemal Meran – Denizli, TURKEY
Prof. Stanisław Mitura Dr hc – Koszalin, POLAND
Prof. Abraham Atta Ogwu – Paisley, UK
Prof. Jerzy Pacyna – Cracow, POLAND
Prof. Lucjan Pająk – Katowice, POLAND
Prof. Peter Palček – Zilina, SLOVAK REPUBLIC
Prof. Fusheng Pan – Chongqing, CHINA

Prof. Wojciech Przetakiewicz – Szczecin, POLAND
Prof. Maria Richert – Cracow, POLAND
Prof. Maria H. Robert – Campinas, BRAZIL
Prof. Mario Rosso – Turin, ITALY
Prof. Stanislav Rusz – Ostrava, CZECH REPUBLIC
Prof. Yuriy Shalapko – Khmelnytsky, UKRAINE
Prof. Jan Sieniawski – Rzeszow, POLAND
Prof. Paul Siffert – Strassburg, FRANCE
Prof. Jorge A. Sikora – Mar del Plata, ARGENTINA
Prof. Božo Smoljan – Rijeka, CROATIA
Prof. Jerry Sokolowski – Windsor, CANADA
Prof. Mirko Soković – Ljubljana, SLOVENIA
Prof. Antonio Sousa – Fredericton, CANADA
Prof. Zinovij Stotsko – Lvov, UKRAINE
Prof. Michał Szota – Częstochowa, POLAND
Prof. Vasco Teixeira – Braga, PORTUGAL
Prof. Sabu Thomas – Kottayam, Kerala, INDIA
Prof. Miklos Tisza – Miskolc, HUNGARY
Prof. Jose M. Torralba Dr hc – Madrid, SPAIN
Prof. Laszlo Toth – Miskolc, HUNGARY
Prof. Algirdas V. Valiulis – Vilnius, LITHUANIA
Prof. Jorge Roberto Vargas Garcia – Mexico City, MEXICO
Prof. Tadeusz Wierzchoń – Warsaw, POLAND
Prof. Abdalla Wifi – Cairo, EGYPT
Prof. Władysław K. Włosiński Dr hc – Warsaw, POLAND
Prof. Gwomei Wu – Taoyuan, TAIWAN
Prof. Senay Yalcin – Istanbul, TURKEY
Prof. Prasad KVD Yarlagadda – Brisbane, AUSTRALIA
Prof. Bekir Sam Yilbas – Dhahran, SAUDI ARABIA
Prof. Dagou Zeze – Durham, UNITED KINGDOM
Prof. Paweł Zięba – Cracow, POLAND
Prof. Jozef Zrník – Plzen, CZECH REPUBLIC
Prof. Marian Żenkiewicz – Bydgoszcz, POLAND
Prof. Marcel Žitňanský – Bratislava, SLOVAK REPUBLIC

Patronage



World Academy of Materials
and Manufacturing Engineering



Polish Academy of Sciences,
Committee of Materials Science,
Section of Metallic Materials



Association of Computational Materials
Science and Surface Engineering

Publishing cooperation



Springer

Financial support

In 2015 the publication of the Journal is financially supported by the Ministry of Science and Higher Education in Poland.

Journal Registration

The Journal is registered by the 1st Civil Department of the District Court in Gliwice, Poland at number 278.

Abstracting services

This Journal is sent to individual receivers from ca. 50 countries of the world and is delivered to the National Libraries and Universities and also to other scientific institutions in ca. 50 countries of the world. The electronic system of Reading Direct allows to access to the electronic version of that journal on-line, in the promotional period free of charge. This Journal is included in the reference list of the Polish Ministry of Science and Higher Education (9 points). The Journal is cited by Abstracting Services such as:



The procedure of its registration in the databases of Compendex, CiteSeer, GetCited, Web of science, Engineering Village, Public Knowledge Project, Edith Cowan University's Institutional Repository, Journals Online and Inspec has begun.

Publisher



International OCSCO World Press
ul. Zygmunta Starego 6/30
44-100 Gliwice, Poland

e-mail: info@archivesmse.org

Bank account: Stowarzyszenie Komputerowej Nauki o Materiałach i Inżynierii Powierzchni
Bank name: ING Bank Śląski
Bank address: ul. Zwycięstwa 28, 44-100 Gliwice, Poland
Account number/IBAN CODE:
PL76105012981000002300809767
Swift code: INGBPLPW

Gliwice – Sao Paulo – Athens – Osaka – Doha – Worcester – Auckland – Szczecin – Singapore

© 2015 International OCSCO World Press.
All rights reserved.

Reading Direct

This journal is a part of Reading Direct, the free of charge alerting service which sends tables of contents by e-mail for this journal and in the promotion period also the full texts of papers. You can register to Reading Direct at

<http://www.archivesmse.org>

☺ The paper used for this journal meets the requirements of acid-free paper.

Printed in Poland.