Lubrication Science

EDITOR
Mitjan Kalin
Laboratory for Tribology and Interface Nanotechnology
Faculty of Mechanical Engineering
University of Ljubljana Slovenia

EDITOR EMERITUS
Carl E. Snyder, Jr
Air Force Research Laboratory,
Dayton, Ohio USA

H. A. Spikes
Chairman, Imperial College,
University of London, UK

EDITORIAL BOARD
Koshi Adachi, Tohoku University, Japan
Pranesh Aswath, University of Texas at Arlington, USA
Scott Bair, Georgia Institute of Technology, US
Wilfried J Bartz, Technische Akademie Esslingen, Germany
Benyebka Bou-Said, INSA-Lyon, France
Philippa Cann, Imperial College, UK
Mike Chandross, Sandia National Laboratories, US
Enrico Ciulli, University of Pisa, Italy
Fabrice Dassenoy, Ecole Centrale de Lyon, France
Patrick De Baets, Ghent University, Belgium
Donfeng Diao, Xi’an Jiaotong University, China
Nicole Doerr, AC2T research GmbH, Austria
Rob Dwyer-Joyce, University of Sheffield, UK

Ali Erdemir, Argonne National Laboratory, US
George R Fenske, Argonne National Laboratory, US
Luis Ferreira, University of Porto, Portugal
Friedrich Franek, Vienna University of Tribology, Austria
Tabassumul Haque, ExxonMobil Research and Engineering, US
Tomoko Hirayama, Doshisha University, Japan
Staffan Jacobson, Uppsala University, Sweden
Roland Larsson, Lulea University of Technology, Sweden
Hong Liang, Texas A&M University, US
Piet Lugt, SKF Engineering and Research Centre, Netherlands
Jean Michel Martin, ECL LTDS, France

Ichiro Minami, Iwate University, Japan
Clotilde Minfray, Ecole Centrale de Lyon, France
Ardian Morina, University of Leeds, UK
Daniel Neligas, INSA Lyon, France
Somuri Prasad, Sandia National Laboratories, US
M. Clelia Righi, University of Modena and Reggio Emilia, Italy
Leslie R Rudnick, Ultraceh Inc., US
Greg Sawyer, University of Florida, US
Tom Scharf, The University of North Texas, US
Dick Schipper, University of Twente, Netherlands
Nic Spencer, ETH Zurich, Switzerland
Joichi Sugimura, Kyushu University, Japan
Victoria van Camp, SKF Lubrication Systems, US
Information for Subscribers

The Lubrication Science is published in 8 issues per year. Institutional subscription prices for 2019 are: Print & Online: US$6296.00 (US and Rest of World), €4065.00 (Europe), £3220.00 (UK). Prices are exclusive of tax. Canadian GST/HST and European VAT will be applied at the appropriate rates. For more information on current tax rates, please go to https://onlinelibrary.wiley.com/library-info/products/price-lists/payment. The price includes online access to the current and all online back files to January 1st 2015, where available. For other pricing options, including access information and terms and conditions, please visit https://onlinelibrary.wiley.com/library-info/products/price-lists. Terms of use can be found here: https://onlinelibrary.wiley.com/terms-and-conditions

Delivery Terms and Legal Title

Where the subscription price includes print issues and delivery is to the recipient's address, delivery terms are Delivered at Place (DAP); the recipient is responsible for paying any import duty or taxes. Title to all issues transfers Free of Board (FOB) our shipping point, freight prepaid. We will endeavour to fulfil claims for missing or damaged copies within six months of publication, within our reasonable discretion and subject to availability.

Backstock

Back issues: Single issues from current and recent volumes are available at the current single issue price from cs-journals@wiley.com. Earlier issues may be obtained from Periodicals Service Company, 351 Fairview Avenue – Ste 300, Hudson, NY 12534, USA. Tel: +1 518 822-9300, Fax: +1 518 822-9305, Email: psc@periodicals.com

Contact Details

Journal Customer Services: For ordering information, claims and any enquiry concerning your journal subscription please go to https://hub.wiley.com/community/support/onlinelibrary or contact your nearest office.

Americas: Email: cs-journals@wiley.com; Tel: +1 781 388 8598 or +1 800 835 6770 (toll free in the USA & Canada).

Europe, Middle East and Africa: Email: cs-journals@wiley.com; Tel: +44 (0) 1865 778315.

Asia Pacific: Email: cs-journals@wiley.com; Tel: +65 6511 8000.

Japan: For Japanese speaking support, Email: cs-japan@wiley.com;

Visit our Online Customer Help available in 7 languages at https://hub.wiley.com/community/support/onlinelibrary

Statement on Research4Life

Wiley is a founding member of the UN-backed HINARI, AGORA, and OARE initiatives. They are now collectively known as Research4Life, making online scientific content available free or at nominal cost to researchers in developing countries. Please visit Wiley’s Content Access – Corporate Citizenship site:

http://www.wiley.com/WileyCDA/Section/id-390082.html

Copyright and Copying

(in any format)

© 2019 John Wiley & Sons, Ltd. All rights reserved.

No part of this publication may be reproduced, stored or transmitted in any form or by any means without the prior permission in writing from the copyright holder. Authorization to copy items for internal and personal use is granted by the copyright holder for libraries and other users registered with their local Reproduction Rights Organisation (RRO), e.g. Copyright Clearance Center (CCC), 22 Rosewood Drive, Danvers, MA 01923, USA (www.copyright.com), provided the appropriate fee is paid directly to the RRO. This consent does not extend to other kinds of copying such as copying for general distribution, for advertising or promotional purposes, for republication, for creating new collective works or for resale. Permissions for such reuse can be obtained using the RightsLink “Request Permissions” link on Wiley Online Library. Special requests should be addressed to: permissions@wiley.com

Disclaimer

The Publisher and Editors cannot be held responsible for errors or any consequences arising from the use of information contained in this journal; the views and opinions expressed do not necessarily reflect those of the Publisher and Editors, neither does the publication of advertisements constitute any endorsement by the Publisher and Editors of the products advertised.

Abstracting and Indexing

The Journal is indexed by: Advanced Technologies & Aerospace Database (ProQuest), Biological Science Database (ProQuest), CAS: Chemical Abstracts Service (ACS), Chemical Abstracts Service/SciFinder (ACS), COMPENDEX (Elsevier), Current Contents: Engineering, Computing & Technology (Clarivate Analytics), EnCompass Lit (Elsevier), INSPEC (IET), Journal Citation Reports/Science Edition (Clarivate Analytics), Materials Science & Engineering Database (ProQuest), Natural Science Collection (ProQuest), Science Citation Index Expanded (Clarivate Analytics), SciTech Premium Collection (ProQuest), SCOPUS (Elsevier), Technology Collection (ProQuest), TEMAJ: Technik und Management (WTI-Frankfurt eG)

Online Open

Lubrication Science accepts articles for Open Access publication. Please visit https://authorservices.wiley.com/author-resources/Journal-Authors/open-access/onlineopen.html for further information about OnlineOpen.

Manuscript Submission

For submission instructions, subscription and all other information visit: wileyonlinelibrary.com/journal/ls

Wiley’s Corporate Citizenship Initiative Statement

Wiley’s Corporate Citizenship initiative seeks to address the environmental, social, economic, and ethical challenges faced in our business and which are important to our diverse stakeholder groups. Since launching the initiative, we have focused on sharing our content with those in need, enhancing community philanthropy, reducing our carbon impact, creating global guidelines and best practices for paper use, establishing a vendor code of ethics, and engaging our colleagues and other stakeholder in our efforts. Follow our progress at www.wiley.com/go/citizenship

Production Information

For manuscripts that have been accepted for publication, please contact: Gil S. Millan
E-mail: LScorrections@wiley.com

Printer Details

Printed on acid-free paper
Printed in Singapore by Markono Print Media Pte Ltd.

Periodical Statement

LUBRICATION SCIENCE. (Print ISSN 0954-0075 Online ISSN 1557-6833), is published in January, March, April, June, August, October, November and December. US mailing agent: Mercury Media Processing, LLC, 1850 Elizabeth Avenue, Suite #C, Rahway, NJ 07065 USA. Periodical postage paid at Rahway, NJ

Postmaster: Send all address changes to LUBRICATION SCIENCE, Journal Customer Services, John Wiley & Sons Inc., C/O The Sheridan Press, PO Box 465, Hanover, PA 17331.
Research Articles
Tribological behavior of zirconium phosphate-1,4-dimethylpiperazine compound as lubricant additives
W. Niu, L. Liu, H. Xu and J. Dong ............................................................. 51
Tribological characterisation of plant oil derived fatty acid esters of higher polyols: Comparative experimental study
Tribological performance of oil-based ZnO and diamond nanofluids
X. Han, G. C. Barber, Z. Zhang, S. Thrush, J. D. Schall, Z. Li and B. Wang ................. 73
A systematic review on correlation between biochemical and mechanical processes of lubricant film formation in joint replacement of the last 10 years
R. Rufaquà, M. Vrbka, D. Choudhury, D. Hemzal, I. Křupka and M. Hartl ................. 85