

# Journal of Scientific & Industrial Research

## Editorial Board

### Dr G S Mukherjee

Additional Director  
Head HRD and Technical  
Coordinator  
DESIDOC, Metcalfe House,  
Delhi – 110 054  
Email: gs\_mukherjee@rediffmail.com

### Dr P C Angelo

Director,  
Metal Testing & Research Centre  
PSG College of Technology  
Coimbatore – 641 004  
E-mail: angelo\_psg@yahoo.com

### Prof Mihir Kanti Chaudhuri

Vice Chancellor, Tezpur  
University  
Napaam, Tezpur  
Sonitpur, Assam – 784 028  
Email: mkc@tezu.ernet.in

### Dr J P Tamang

Dean, School of Life Sciences  
Professor, Department of  
Microbiology  
Sikkim Central University  
Tadong, Gangtok – 737 102  
E-mail: jyoti\_tamang@hotmail.com

### Prof Amartya Mukhopadhyay

Department of Metallurgical  
Engineering & Material Science  
IIT Bombay, Powai,  
Mumbai – 400 076  
E-mail: amartya.28nov@gmail.com

### Prof T Sundararajan

Department of Mechanical  
Engineering  
IIT Madras  
Chennai – 600 036  
E-mail: tsundar@iitm.ac.in

### Prof J Chattopadhyaya

Program of Chemical Biology,  
Department of Cell and Molecular  
Biology  
Biomedical Centre,  
Uppsala University  
SE-75 123 Uppsala Sweden  
E-mail: jyoti@boc.uu.se

### Prof Grace T R Lin

Institute of Management of  
Technology, No. 1001  
Ta Hsueh Road, National  
Chiao Tung University  
HsinChu City, Taiwan  
Email: gtrl@faculty.nctu.edu.tw

### Dr Sudhakar Mahajanam

ConocoPhillips Co 248 Geo  
Science Building  
Bartlesville, OK74 004, USA  
Email: sudhakar.p.mahajanam@  
conocophillips.com

### Dr R A Osornio

HSP digital-CA Mecatronica,  
Facultad de Ingenieria Campus  
San Juan Del Rio,  
Universidad Autonoma de Queretaro,  
San Juan Del Rio, Queretaro,  
Mexico  
E-mail: raosornio@hspdigital.org

### Dr Rer Nat Hesham A El Ensashy

Institute of Bio products  
Development  
University Technology Malaysia,  
81 310 Johor Bahru, Johor, Malaysia  
E-mail: henshasy@ibd.utm.my

### Dr Ajay K Ray

Professor and Chair  
Department of Chemical and  
Biochemical Engineering  
Thompson Engineering Building  
Western University  
London, ONN6A5B9. Canada  
Email: aray@eng.uwo.ca

**Director, CSIR-NIScPR (Ex-Officio)**

**Editor:** Dr Narendra Kumar Sahoo  
**Editorial Assistant:** Mr Kashmiri Lal

**Published by National Institute of Science Communication and Policy Research, (erstwhile CSIR-NISCAIR)**  
**Vigyan Sanchar Bhawan, Dr K S Krishnan Marg, New Delhi – 110 012**  
**Phone:** 25841143, 25846301; **Fax:** (0091)-11-25847062; **E-mail:** jsir@niscpr.res.in; **Website:** www.niscpr.res.in

The *Journal of Scientific & Industrial Research* is issued monthly.

The Institute assumes no responsibility for the statements and opinions advanced by contributors. The editorial staff in their work of examining papers received for publication is assisted, in an honorary capacity, by a large number of distinguished scientists working in various parts of India and abroad.

Communications regarding contributions for publication in the journal and books for review should be addressed to the Editor, Journal of Scientific & Industrial Research, National Institute of Science Communication and Policy Research, Dr K S Krishnan Marg, New Delhi 110 012, India.

Annual Subscription: ₹ 5760.00 \$ 780.00

Single Copy: ₹ 576.00 \$ 78.00

(\*inclusive of first class mail)

Correspondence regarding subscriptions and advertisements should be addressed to the Head, BDG&I, National Institute of Science Communication and Policy Research, Dr K S Krishnan Marg, New Delhi – 110 012, India ("Subscription Complaint" No. 25843359).

**Phones:** 25843359, 25846301, 25846303-7; **Fax:** (0091)-11-25847062, **E-mail:** sales@niscpr.res.in

Payments in respect of subscriptions and advertisements may be made demand draft/IPO/ECS/NEFT/RTGS payable to NIScPR, New Delhi. The following detail may be used for ECS/NEFT/ RTGS transactions with NIScPR.

Bank name: CANARA Bank Address: NPL Campus, New Delhi 110012, India Branch: NPL Campus, New Delhi

Account No.: 110003874485 Account Name: CSIR-NIScPR, New Delhi 110 012 IFSC Code: CNRB0019100

MICR Code: 110015428 Branch code: 9029 SWIFT code: CNRBINBBBFD

**Claims for missing numbers of the journal will be allowed only if received within three months of the date of issue of the journal plus the time normally required for postal delivery of the journal and the claim.**

© 2023. Council of Scientific & Industrial Research, New Delhi 110 001