

Journal

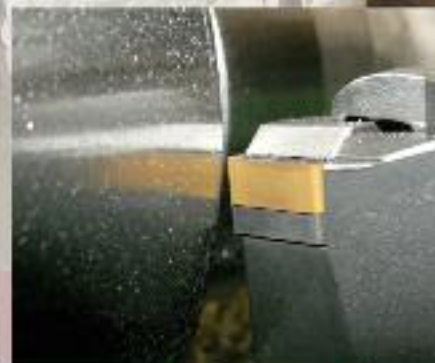
of Achievements in Materials
and Manufacturing Engineering



Published monthly as the organ of the World Academy of Materials and Manufacturing Engineering

Editor-in-Chief Prof. Leszek A. Dobrzański

Volume 27 • Issue 2 • April 2008





Journal

of Achievements in Materials
and Manufacturing Engineering

PUBLISHED SINCE 1992

formerly as **Proceedings on
Achievements in Mechanical
and Materials Engineering**

Published monthly as the organ of the World Academy of Materials and Manufacturing Engineering

Editor-in-Chief

Prof. Leszek A. Dobrzański - Gliwice, Poland

Deputies Editor-in-Chief

South America

Prof. Maria Helena Robert - Campinas, Brazil

North America

Prof. George Totten - Portland, USA

Europe

Prof. Jose Manuel Torralba - Madrid, Spain

Asia

Prof. Yong Taek Im - Daejeon, South Korea

Australia

Prof. Kanaka Durga Vara Prasad Yarlagadda
- Brisbane, Australia

Africa

Prof. Abdalla Wifi - Cairo, Egypt

Associate Editors

Dr Mirosław Bonek
Dr Małgorzata Drak
Dr Klaudiusz Gołombek
Ms Marzena Kraszewska, MA
Dr Janusz Madejski
Dr Daniel Pakuła

Editorial Assistance

Mr Wojciech Borek, MSc
Mr Mariusz Król, MSc
Mr Szymon Malara, MSc
Mr Marcin Staszuk, MSc

Reading Direct

Dr Adam Polok
Mr Piotr Zarychta, MSc

Editorial Board

Prof. Gilmar Batalha - Sao Paulo, Brazil
Prof. Emin Bayraktar - St-Ouen, France
Prof. Milan Brandt - Swinburne, Australia
Prof. Tara Chandra - Wollongong, Australia
Prof. Antonio Cuhna - Guimaraes, Portugal
Prof. Marek Dollar - Oxford, Ohio, USA
Prof. J. Paulo Davim - Aveiro, Portugal
Prof. Sabahudin Ekinović - Zenica, Bosnia and Herzegovina
Prof. Renato Esposito - Naples, Italy
Prof. Spilios Fassois - Patras, Greece
Prof. Swadhin Ghosh - Rösrath, Germany
Prof. Janez Grum - Ljubljana, Slovenia
Prof. Toshio Haga - Osaka, Japan
Prof. Abdel Magid Hamouda - Selangor, Malaysia
Prof. Stuart Hampshire - Limerick, Ireland
Prof. Lauri Holappa - Espoo, Finland
Prof. John Barry Hull - Nottingham, United Kingdom
Prof. Mark James Jackson - West Lafayette, Indiana, USA
Prof. Krzysztof Jemielniak - Warsaw, Poland
Prof. Jerzy Jędrzejewski - Wrocław, Poland
Prof. Yosef Katz - Beer Sheva, Israel
Prof. Andrzej Klimpel - Gliwice, Poland
Prof. Ivars Knets - Riga, Latvia
Prof. Janez Kopac - Ljubljana, Slovenia
Prof. Karl Kuzman - Ljubljana, Slovenia
Prof. Anatolij Kuzmenko - Khmielnitsky, Ukraine
Prof. Petr Louda - Liberec, Czech Republic
Prof. Stanisław Mitura - Łódź, Poland
Prof. Andrew Nee - Singapore, Singapore
Prof. Jerzy Nowacki - Szczecin, Poland
Prof. Abraham Ogwu - Paisley, United Kingdom
Prof. Fusheng Pan - Chongqing, China
Prof. Mario Rosso - Turin, Italy
Prof. Antonio Sousa - Fredericton, NB, Canada
Prof. Božo Smoljan - Rijeka, Croatia
Prof. Jerry Sokolowski - Windsor, Ontario, Canada
Prof. Zinovij Stotsko - Lviv, Ukraine
Prof. Jerzy Świder - Gliwice, Poland
Prof. Ming-Jen Tan - Singapore, Singapore
Prof. Boris Tomov - Rousse, Bulgaria
Prof. Marcel Van De Voorde - Brussels, Belgium
Prof. Senay Yalcin - Istanbul, Turkey
Prof. Bekir Sam Yilbas - Dhahran, Saudi Arabia



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.journalamme.org>

Patronage



World Academy of Materials
and Manufacturing Engineering



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



International Federation of Heat Treatment
and Surface Engineering



Association of Computational Materials
Science and Surface Engineering



Institute of Engineering Materials
and Biomaterials of Silesian University
of Technology, Gliwice, Poland

Financial support

In 2008 the publication of the Journal is financially supported by the Ministry of Science and Higher Education in Poland.

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 (6 points). The procedure leading to the citation of that journal by Abstracting Services has already begun.

Journal Registration

The Journal is registered by the Civil Department of the District Court in Gliwice, Poland at number 279

Publisher



Gliwice 44-100, Poland
ul. S. Konarskiego 18a/366
e-mail: info@journalamme.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 – Campinas – Portland – Madrid – Daejeon – Brisbane – Cairo

© 2008 International OCSCO World Press. All rights reserved
The paper used for this Journal meets the requirements of acid-free paper
Printed in Poland

Cover story

One of the basic group of engineering materials among metals, polymers, composites is ceramics. A group of non-organic materials having ionic and covalent inter-atomic bonds created usually in high-temperature processes is called ceramics. Glass and glass ceramics is also included in that group. Ceramic materials are composed of at least two elements, and often their bigger number and their crystalline structure is more complex than the one of metals. Between atoms in those materials there are bonds of either purely ionic or wholly covalent ones, and in many ceramic materials there is a combination of those two kinds of bonds. In ceramic materials in which ionic bonds predominate, there is the counterbalance between positively charged cations – ions of metals giving back their valence electrons and negatively charged – ions of non-metals.

Structure of some ceramic materials is characterised by the fact that the number of cations and anions marked adequately as A and X is identical. Suitable phases marked as A and X, can be characterised by a few types of crystallographic structures. In a case when charges of cations and anions are not the same, phases of A_mX_p type, where m or/and p ≠ 1, eg. AX₂ or A₂X₃ can appear. It is possible that also more than one type of cations appear. In a case when two types of cations marked respectively by A and B appear phases of $A_mB_nX_p$ types are created. Since the 1930s ceramic fibres, which production developed after 1965, mainly because of requirements of aerospace and airspace industry, mainly for the application of composite materials, have been known.

A man mastered the process of ceramics firing before he familiarised with metals and their alloys. There are proves for that in many parts of the world, mainly in the region of Mesopotamia and Anatolia. In the Bible in the 1st Book of Moses the following sentence can be found "Let us go to prepare bricks and fire them in fire". The unusual proof of mastering this technique in Asia is a Terracotta Army guarding the grave of the First Emperor of China – Qin Shi Huangdi dated from 3rd century B.C., situated near present Xi'an in the north Chinese province Shaanxi. No records about warriors sculptured in an underground chamber are saved – it was assumed that they were to be hidden for always. The Emperor Qin Shi Huangdi as the first one united China during the reign of the dynasty of Qin, and then he was engaged with great building enterprises, including the Great Wall of China. The Terracotta Army, which was found by peasants digging the well in 1974, survived till today probably in the best conditions than others. Before peasants' eyes three rectangular chambers, formed in the earth and having the floor made of bricks, leaned on wooden pillars appeared. The digged chambers were covered by hangars, so that the rows of warriors can be seen in the place they were built. 2000-year-old groups of terracotta warriors (Bingma Yong) are a fantastic proof of skilful artists and the power of imperial authority. In the area of the 250-metre-long and 70-metre-broad excavations 1100 warriors, 32 horses, 8 two-wheel chariots were found, and it is estimated that ca. 5000 warriors have been still waiting for the discovery. The view of the army looking menacingly at comers is unforgettable impression. It is possible to observe the 1.80-metre-tall sculptures from the pavements, especially prepared for tourists, in order to see technical details. Figures from thighs up are empty inside. Separately sculpted hands and heads having individual faces are stuck to serially made trunks; figures differ also with military distinctions. Some of researches think that the figures are simply realistic portraits of given members of the imperial guard. Soldiers with plaited hairs around heads are dressed in combative tunics reaching knees, and figures in outside rows – in leather armours which were destroyed today. There are also traces of paint proving that grey sculptures were originally bright yellow, purple or green.

