



**Volume 42**  
**Issue 2**  
**April 2010**  
**Pages 65-128**

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

#### Deputies Editor-in-Chief

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

#### Associate Editors

**Dr Mirosław Bonek** – Gliwice, POLAND  
**Dr Małgorzata Drak** – Gliwice, POLAND  
**Dr Klaudiusz Gotombek** – Gliwice, POLAND  
**Dr Daniel Pakuła** – Gliwice, POLAND

#### Production Editor

**Ms Marzena Kraszewska, MA** – Gliwice, POLAND

#### Reading Direct Editors

**Mr Adam Jagiełło, MSc** – Gliwice, POLAND  
**Mr Piotr Zarychta, MSc** – Gliwice, POLAND

#### Submission Officer

**Dr Magdalena Polok-Rubiniec** – Gliwice, POLAND

#### Computer typesetters

**Ms Anna Ahtelik, MSc** – Gliwice, POLAND  
**Ms Justyna Hajduczek, MSc** – Gliwice, POLAND  
**Mr Paweł Jarka, MSc** – Gliwice, POLAND  
**Dr Anna Włodarczyk-Fligier** – Gliwice, POLAND  
**Dr Bogusław Ziębowicz** – Gliwice, POLAND

#### International Editorial Board Members

**Prof. Dorel Banabic** – Cluj Napoca, ROMANIA  
**Prof. Tadeusz Bołd** – Gliwice, POLAND  
**Prof. Tara Chandra** – Wollongong, AUSTRALIA  
**Prof. Antonio Cunha** – Guimaraes, PORTUGAL  
**Prof. Jan Cwajna** – Katowice, POLAND  
**Prof. Edward D. Doyle** – Swinburne, AUSTRALIA  
**Prof. Georgy Drapak** – Khmelnytsky, UKRAINE

**Prof. Jan Dutkiewicz** – Cracow, POLAND  
**Prof. Hong Hocheng** – Hsinchu, TAIWAN  
**Prof. Stuart Hampshire** – Limerick, IRELAND  
**Prof. Adam Hernas** – Katowice, POLAND  
**Prof. Marek Hetmańczyk** – Katowice, POLAND  
**Prof. Werner Hufenbach** – Dresden, GERMANY  
**Prof. David Hui** – New Orleans, USA  
**Prof. Yong-Taek Im** – Daejeon, KOREA  
**Prof. Leopold Jeziorski Dr hc** – Częstochowa, POLAND  
**Prof. Jan Kazior** – Cracow, POLAND  
**Prof. Albert Kneissel** – Leoben, AUSTRIA  
**Prof. Ivars Knets** – Riga, LATVIA  
**Prof. Janez Kopac Dr hc** – Ljubljana, SLOVENIA  
**Prof. Piotr Kula** – Łódź, POLAND  
**Prof. Krzysztof J. Kurzydłowski** – Warsaw, POLAND  
**Prof. Karl Kuzman** – Ljubljana, SLOVENIA  
**Prof. Petr Louda** – Liberec, CZECH REPUBLIC  
**Prof. Eugeniusz Łągiewka** – Katowice, POLAND  
**Prof. Adolf Maciejny Dr hc** – Katowice, POLAND  
**Prof. Bogusław Major** – Cracow, POLAND  
**Prof. Stanisław Mitura Dr hc** – Łódź, POLAND  
**Prof. Ryszard Nowosielski** – Gliwice, POLAND  
**Prof. Abraham Atta Ogwu** – Paisley, UK  
**Prof. Jerzy Pacyna** – Cracow, POLAND  
**Prof. Fusheng Pan** – Chongqing, CHINA  
**Prof. Lucjan Pająk** – Katowice, POLAND  
**Prof. Jan Pilarczyk** – Gliwice, POLAND  
**Prof. Wojciech Przetakiewicz** – Warsaw, POLAND  
**Prof. Maria H. Robert** – Campinas, BRAZIL  
**Prof. Mario Rosso** – Turin, ITALY  
**Prof. Jan Sieniawski** – Rzeszów, POLAND  
**Prof. Paul Siffert** – Strassburg, FRANCE  
**Prof. Jorge A. Sikora** – Mar del Plata, ARGENTINA  
**Prof. Bozo Smoljan** – Rijeka, CROATIA  
**Prof. Jerry Sokolowski** – Windsor, CANADA  
**Prof. Mirko Sokovic** – Ljubljana, SLOVENIA  
**Prof. Antonio Sousa** – Fredericton, CANADA  
**Prof. Vasco Teixeira** – Braga, PORTUGAL  
**Prof. Miklos Tisza** – Miskolc, HUNGARY  
**Prof. Laszlo Toth** – Miskolc, HUNGARY  
**Prof. Boris Tomov Dr hc** – Rousse, BULGARIA  
**Prof. Jose M. Torralba Dr hc** – Madrid, SPAIN  
**Prof. Algirdas V. Valiulis** – Vilnius, LITHUANIA  
**Prof. Tadeusz Wierzchoń** – Warsaw, POLAND  
**Prof. Abdalla Wifi** – Cairo, EGYPT  
**Prof. Władysław K. Włosiński Dr hc** – Warsaw, POLAND  
**Prof. Stefan Wojciechowski Dr hc** – Warsaw, POLAND  
**Prof. Gwomei Wu** – Taoyuan, TAIWAN  
**Prof. Senay Yalcin** – Istanbul, TURKEY  
**Prof. Bekir Sam Yilbas** – Dhahran, SAUDI ARABIA  
**Prof. Andrzej Zieliński** – Gdańsk, POLAND  
**Prof. Paweł Zięba** – Cracow, POLAND  
**Prof. Jozef Zrník** – Plzen, CZECH REPUBLIC  
**Prof. Marcel Zitnansky** – Bratislava, SLOVAK REPUBLIC

## Patronage



World Academy  
of Materials  
and Manufacturing  
Engineering



Association of  
Computational Materials  
Science and Surface  
Engineering



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



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

## Financial support

The efforts to achieve the financial support of the Journal in 2010 from the Ministry of Science and Higher Education in Poland have begun.

## 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 Journal is cited by Abstracting Services such as:



DIRECTORY OF  
OPEN ACCESS  
JOURNALS



SCIRUS  
for scientific information only



SCOPUS™

The procedure of its registration in the databases of Compendex, CiteSeer, GetCited and Web of science has begun.

## Journal Registration

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

## Publisher



INTERNATIONAL  
**OCSCO**  
WORLD PRESS

International OCSCO World Press  
ul. S. Konarskiego 18a/366,  
44-100 Gliwice, Poland

e-mail: [info@archivesmse.org](mailto: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 – West  
Lafayette – Auckland – Szczecin – Singapore

© 2010 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.

## It was said...



### DR GEORGE E. SMITH

#### The Nobel Prize Laureate in Physics 2009

“It is heartening for us to see that the use of the CCD as solid state imaging devices initiated a revolution in which photographic film and electron beam imaging tubes were relegated to history. As part of the accelerating rise in information technology, it has helped transform the way we live our lives. Think of snapping a photo with your cell phone and instantly sending it to a friend thousands of miles away instead of finishing the roll of film, having it developed, putting it in an envelope and posting it to a far away country. Much easier to forget about it. The device is being used in many other applications including TV cameras, satellite surveillance and a variety of medical imaging applications. The one application which makes maximum use of the devices characteristics is in astronomy. CCD's have been used to gaze much deeper and more accurately into the universe than ever before. This has resulted from the increased efficiency, lower noise, and larger dynamic range using CCDs than that which can be attained with photographic film. Also, the fact that you are using the same detector with each exposure allows you to correct for systematic errors in the CCD. No device is ever perfect nor is photographic film. Photographic film is a different detector with every shot. I was once thanked by a young astronomer for originating the device that created an avalanche of new data and made creating an original thesis project much, much easier. I have also been thanked by mobile TV cameraman for the big reduction in weight of their load.”

From the speech at the Nobel Banquet on 10<sup>th</sup> December 2009 in Stockholm, Sweden

# Editorial

Istanbul in Turkey, historically also known as Byzantium and Constantinople, the largest city in Turkey and fifth largest city proper in the world with a population of 12.8 million is a peculiar symbol of the international cooperation, as the only city in the World situated in two continents. Of course, in order to find out the full information about this city it is enough to open Wikipedia in the Internet. Etymologically, Istanbul derives from the Medieval Greek phrase "is tin 'polin" or, in the Aegean dialect, "is tan 'polin", which means "in the city" or "to the city". Like Rome, Istanbul has been called "The City of Seven Hills" because the oldest part of the city is supposedly built on seven hills, each of which bears a historic mosque. Istanbul is also a megacity, as well as the cultural, economic, and financial centre of Turkey. The city is located on the Bosphorus Strait and encompasses the natural harbour known as the Golden Horn, in the northwest of the country. It extends both on the European (Thrace) and on the Asian (Anatolia) sides of the Bosphorus. Three historic quarters of Istanbul, looking south from Beyoğlu to the "historic peninsula" separated by the Golden Horn to the farther right and Kadıköy on the Asian side separated by the entrance of the Bosphorus to the left. Istanbul Province has 39 districts, of which 27 form the city proper of Istanbul, also called Greater Istanbul, administered by the Istanbul Metropolitan Municipality. Istanbul's districts are divided into three main areas. The historic peninsula of old Istanbul corresponds approximately to the extent of Constantinople in the 15<sup>th</sup> century; it comprises the districts of Eminönü and Fatih. This area lies on the southern shores of the Golden Horn, which separates the old city centre from the northern and younger parts of the European side. The historic peninsula ends with the Theodosian Land Walls in the west. The peninsula is surrounded by the Sea of Marmara on the south and the entrance of the Bosphorus on the east. North of the Golden Horn are the historical Beyoğlu and Beşiktaş districts, where the last Sultan's palace is located, followed by a chain of former villages such as Ortaköy and Bebek along the shores of the Bosphorus. On both the European and Asian sides of the Bosphorus, wealthy Istanbulites built luxurious chalet mansions, called yalı, which were used as summer residences. The districts of Üsküdar (ancient Chrysopolis) and Kadıköy (ancient Chalcedon) which are located on the Asian side were originally separate cities (like the district of Beyoğlu – medieval Pera – on the European side also used to be.) These cities have eventually been absorbed by Istanbul and have become its districts. Today, the Asian side of the city has numerous modern residential areas and business districts, and is home to around one-third of Istanbul's population. In its long history, Istanbul has served as the capital city of the Roman Empire (330-395), the Eastern Roman (Byzantine) Empire (395-1204 and 1261-1453), the Latin Empire (1204-1261), and the Ottoman Empire (1453-1922). The historic areas of Istanbul were added to the UNESCO World Heritage List in 1985. When the Republic of Turkey was founded in 1923 by Mustafa Kemal Atatürk, the capital was moved from Istanbul to Ankara. In the early years of the republic, Istanbul was overlooked in favour of the new capital. However, starting from the late 1940s and early 1950s, Istanbul underwent great structural change, as new public squares (such as Taksim Square), boulevards and avenues were constructed throughout the city; sometimes at the expense of the demolition of many historical buildings. Starting from the 1970s, the population of Istanbul began to rapidly increase, as people from Anatolia migrated to the city in order to find employment in the many new factories that were constructed at the outskirts of the sprawling metropolis. The city boundaries cover a surface area of 1,830.93 square kilometres, while the metropolitan region, or the Province of Istanbul, covers 6,220 square kilometres.

Throughout its long history, Istanbul has acquired a reputation for being a cultural and ethnic melting pot. As a result, there are many historical mosques, churches, synagogues, palaces, castles and towers to visit in the city. Some of these historical structures, which draw millions to the city every year, reflect the heart and soul of Istanbul. The famous Maiden's (Leander's) Tower, one of the symbols of Istanbul, was originally built by the ancient Athenian general Alcibiades in 408 BC to control the movements of the Persian ships in the Bosphorus strait. Hippodrome of Constantinople is one of the most important monuments of Roman architecture in the city including the Column of Constantine, which was erected in 330 by Constantine the Great for marking the declaration of the new capital city of the Roman Empire. The other Roman era structures in the city include the Mazulkemer Aqueduct, the Valens Aqueduct, the Column of the Goths at the Seraglio Point, the Million which served for calculating the distances between Constantinople and the other cities of the Roman Empire, the Great Palace of Constantinople originally built by Constantine as the primary residence of the Roman emperors, and the Hippodrome of Constantinople that was built following the model of the Circus Maximus in Rome. Construction of the Walls of Constantinople began under Constantine the Great, who enlarged the previously existing walls of Byzantium in order to defend the new Roman capital city which quickly grew following its proclamation as Nova Roma. A new set of walls was built further west during the reign of Theodosius II, and rebuilt after an earthquake in 447 in their current shape. The Column of Marcian erected by Marcianus (reigned 450-457) dates from the same period as the triple land walls of Theodosius II. The early Byzantine architecture followed the classical Roman model of domes and arches, but further improved these architectural concepts, as evidenced with the 4<sup>th</sup> century Hagia Irene built by Constantine as the first church in the new Roman capital city. Originally a church, later a mosque, and now a museum, the 6<sup>th</sup> century Hagia Sophia built by Justinian, the latter being the largest structure on Sultanahmet Square in the Eminönü district, and the most important surviving example of Byzantine architecture in the world. It was the largest ever cathedral building in the world for a thousand years, until the completion of the Seville Cathedral in Spain. Following the reconquest of Constantinople from the Latin Crusaders in 1261, the Byzantine emperors almost completely abandoned the Great Palace and Boukoleon Palace, and moved to the Blachernae Palace in the west of the city, near the triple land walls. The Genoese built among others: the Galata Tower, which they named Tower of Christ, at the highest point of the citadel of Galata, in 1348. The Ottoman Turks built the Anadoluhisari on the Asian side of the Bosphorus in 1394, and the Rumelihisari at the opposite (European) shore, in 1452, a year before the conquest of Constantinople. The first mosque on the European side of Istanbul was built inside the Rumeli Castle in 1452. Following the Ottoman conquest of the city, Sultan Mehmed II initiated a wide scale reconstruction plan, which included the construction of grand buildings such as the Topkapı Palace, Grand Bazaar and the Yedikule (Seven Towers) Castle which guarded the main entrance gate of the city, the Porta Aurea (Golden Gate). The first grand mosque which was built in the city proper was the Eyüp Sultan Mosque in around 1459. The mosque was built on the site of the grave of Abu Ayyub al-Ansari, a companion of the Prophet Muhammad who had died outside the land walls of Constantinople (walls of Theodosius II) in 669, during the early skirmishes which preluded the Arab siege (674-678) to take the city. The first imperial mosque inside the city walls was the Fatih Mosque (1470) which was built on the site of the Church of the Holy Apostles, an important Byzantine church originally edified in the time of Constantine the Great. Many other imperial mosques were built in the following centuries, such as the famous Süleymaniye Mosque (1557) which was ordered by Suleiman the Magnificent and designed by the great Ottoman architect Mimar Sinan, and the famous Sultan Ahmet Mosque (1616) which is also known as the Blue Mosque for the blue tiles that adorn its interior. In the centuries following Mehmed II, many new important buildings, such as the Süleymaniye Mosque, Sultanahmet Mosque, Yeni Mosque and numerous others were constructed.



The cooperation between two continents is symbolised by two suspension bridges in Istanbul. The Bosphorus Bridge, also called the First Bosphorus Bridge is one of the two bridges in Istanbul, Turkey, spanning the Bosphorus strait and thus connecting Europe and Asia. The bridge is located between Ortaköy (on the European side) and Beyerbey (on the Asian side). It is a gravity anchored suspension bridge with steel pylons and inclined hangers. The aerodynamic deck is hanging on zigzag steel cables. It is 1,510 m long with a deck width of 39 m. The distance between the towers is 1,074 m and their height over road level is 105 m. The clearance of the bridge from sea level is 64 m. The Bosphorus Bridge had the 4<sup>th</sup> longest suspension bridge span in the world when it was completed in 1973, and the longest outside the United States. At present, it is the 16<sup>th</sup> longest suspension bridge span in the world. The decision to build a bridge across the Bosphorus was taken in 1957 by Prime Minister Adnan Menderes. For the structural engineering work, a contract was signed with the British firm Freeman Fox & Partners in 1968. The bridge was designed by the renowned British civil engineers Sir Gilbert Roberts and William Brown who also designed the Humber Bridge, Severn Bridge, Forth Road Bridge, Auckland Harbour Bridge and the Volta River Bridge. The construction started in February 1970, the ceremonies were attended by President Cevdet Sunay and Prime Minister Süleyman Demirel. The construction was carried out by the Turkish firm Enka Construction & Industry Co. along with the co-contractors Cleveland Bridge & Engineering Co. Ltd. (England) and Hochtief AG (Germany). Thirty-five engineers and 400 men worked on the project. The bridge was completed on 30<sup>th</sup> October 1973, one day after the 50<sup>th</sup> anniversary of the founding of the Republic of Turkey, and opened by President Fahri Korutürk and Prime Minister Naim Talu. Since April 2007, a fully computerized LED lighting system of changing colours and patterns, developed by Philips, illuminates the bridge at night. In the first four years, pedestrians could walk over the bridge, reaching it with elevators inside the towers on both sides. No pedestrians or commercial vehicles like trucks are allowed to use the bridge today. Nowadays, around 180,000 vehicles pass daily in both directions, almost 85% being automobiles. Fully loaded, the bridge sags about 90 cm in the middle of the span.

The Fatih Sultan Mehmet Bridge, named after the 15<sup>th</sup> century Ottoman Sultan Mehmed the Conqueror, who took Constantinople in 1453 and ended the Byzantine Empire also known as the Second Bosphorus Bridge, is a second bridge in Istanbul, Turkey spanning the Bosphorus strait and thus connecting Europe and Asia. The bridge is situated between Hisarüstü (European side) and Kavacak (Asian side). It is a gravity-anchored suspension bridge with steel pylons and inclined hangers. The aerodynamic deck is hanging on double vertical steel cables. It is 1,510 m long with a deck width of 39 m. The distance between the towers is 1,090 m and their height over road level is 105 m. The clearance of the bridge from sea level is 64 m. Fatih Sultan Mehmet Bridge had the 6<sup>th</sup> longest suspension bridge span in the world when it was completed in 1988. At present, it has the 15<sup>th</sup> longest suspension bridge span in the world. The bridge was designed by Freeman Fox & Partners, who had previously also designed the Bosphorus Bridge. An international consortium of three Japanese companies (including IHI Corporation and Mitsubishi Heavy Industries), one Italian and one Turkish company (STFA) carried out the construction works. The bridge was completed on 3<sup>rd</sup> July 1988 and opened by Prime Minister Turgut Özal who drove his official car by himself as the first to pass. The bridge is on the Trans-European Motorway between Edirne and Ankara. The highway bridge has four lanes for vehicular traffic plus one emergency lane in each direction. On weekday mornings, commuter traffic flows mostly westbound to the European part, so five of the eight lanes run westbound and only three eastbound. Conversely, on weekday evenings, five lanes are dedicated to eastbound traffic and three lanes only to westbound. No pedestrians are allowed to use the bridge. Nowadays, around 150,000 vehicles are passing daily in both directions, almost 65% being automobiles.

Istanbul was chosen as joint European Capital of Culture for 2010. Every year the city is a venue of many international scientific conferences. It will be surely visited by all participants of the 13<sup>th</sup> International Materials Symposium organised in October 2010 by the Pamukkale University under the patronage of the World Academy of Materials and Manufacturing Engineering on their way to Denizli. We invite the participants of this important scientific event and other PT Authors to publish their works in the next issues of our Journal.

Prof. Leszek A. Dobrzanski M Dr hc  
Editor-in-Chief of the AMSE  
President of the WAMME  
President of the ACMSSSE