Viennano '15

6th Vienna International Conference

Nano-Technology

Focus: Tribological Aspects

24 - 25 November 2015

Wiener Neustadt, Austria

Book of Abstracts

Organisation:

ÖSTERREICHISCHE TRIBOLOGISCHE GESELLSCHAFT (ÖTG)

In cooperation with:

AC2T research GmbH – Excellence Centre of Tribology

Aerospace & Advanced Composites GmbH

OFI Technologie & Innovation GmbH

Technopol Wiener Neustadt,
ecoplus. Niederösterreichs Wirtschaftsagentur GmbH

Europäische Union. Investitionen in Wachstum & Beschäftigung. Österreich.

Supported by:

Austrian Ministry for Transport, Innovation and Technology
(GZ. BMVIT-612.019/0064-III/I1/2015)

The Province of Lower Austria
(Amt der NÖ Landesregierung, Abteilung Wissenschaft und Forschung, K3-F-595/002-2015)

The City of Wiener Neustadt

IMPRESSUM

Editors: Prof. Dr.-Ing. Wilfried J. BARTZ
Univ.-Prof. Dipl.-Ing. Dr. Friedrich FRANEK

Publisher: ÖSTERREICHISCHE TRIBOLOGISCHE GESELLSCHAFT
Viktor-Kaplan-Str 2 / C, A 2700 Wiener Neustadt,
Tel. +43 (0)676 84516 2300 • FAX: +43 (0)1 253 3033 9100
ISBN 978-3-901657-52-8

Editorial staff: Matthias LIND, Martina GANTAR-HOFINGER

Printing: Ferdinand Berger & Söhne Gesellschaft m.b.H.
Wiener Straße 80, A 3580 Horn

6th Vienna International Conference

Nano-Technology

Focus: Tribological Aspects

24 - 25 November 2015

Wiener Neustadt, Austria

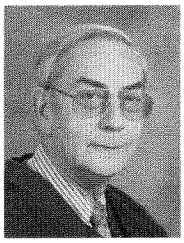
Conference Chairman

Prof. Dr.-Ing.
Wilfried J. BARTZ
Tribology and Lubrication Engineering
Germany

Co-Chairman

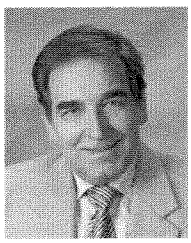
Univ.-Prof. Dipl.-Ing. Dr.
Friedrich FRANEK
The Austrian Tribology Society – ÖTG
Austria

Scientific Board



Prof. Dr.-Ing.
Wilfried .J. BARTZ

Univ.-Prof. Dipl.-Ing. Dr.
Friedrich FRANEK



NANO-TECHNOLOGY
Focus: Tribological Aspects

Nanotechnology is a promising field of technology leading to a hype of research activities and as well of economic initiatives. Tribological effects – to a high extent based on effects and processes on the nano-level – may be optimised if aspects of Nano-Technology are better understood and developed. There are many future-orientated efforts all over the world in order to increase the knowledge. This has not only a fundamental importance but moreover offers an immense range of practical applications. For this reason, Nano-Technology is a rapidly growing field and is therefore a central topic in numerous research programs (e.g. in HORIZON 2020 on the European level).

Nanomaterials show interesting and attractive properties compared to "conventional" materials. Material strength, scratch hardness as well as friction and wear are strongly influenced by the nanostructure. In addition, in the presence of gaseous or liquid media (e.g. lubricants) the material properties vary over a wide range. Subsequently, due to the chemistry of the near-surface the engineering in this field has to consider these sometimes sophisticated facts. These aspects will influence many practical applications, ranging from precision systems to precision surface engineering, tribological systems, microsystems and actuators, and others.

Viennano ´15 presentations address the following fundamental topics:

- Nanoeffects – general aspects
- Friction control by nanoeffects
- Materials design / surface layers
- Measurement, testing and analyses in the nano range
- Nano-Tribology and lubrication

The 6th Vienna International Conference on Nano-Technology **Viennano ´15** offers an opportunity to experts from these and related fields to present their research results as well as applications. It is perceiving itself as a platform to exchange ideas and discuss them with other colleagues working in different fields of research and application and also to present pertinent information to users of nano technology in the different branches of the industry.

The **Viennano '15** is organised in connection with the annual OeTG-Symposium 2015. The participants will benefit from the attractive offer to get informed about the various aspects of the major topics of the symposium. The events offer presentations contributed by industrial specialists and scientists. An exhibition devoted to, e.g., specific methods, measurement techniques tools for analyses and a tour of labs (visiting of respective research institutions at the TFZ) complements the scientific-technical communication among the participants.

Wiener Neustadt, Nov. 2015

Viennano '15

The **Viennano** organizers would like to thankfully acknowledge especially the financial support contributed by

- The Austrian Ministry for Transport, Innovation and Technology, for supporting event technology and catering
- The Province of Niederösterreich, for supporting especially travel expenses for selected conference speakers
- The Lord Major of the City of Wiener Neustadt for the reception in the Wiener Neustadt City Hall
- ecoplus – The Business Agency of Lower Austria, for redounding to the reception in the Wiener Neustadt City Hall.

Disclaimer Note

The content of this publication, data, discussions and conclusions presented by the authors are for information only and are not intended for use without independent substantial investigations on the part of potential users. Options expressed by the Authors are not necessarily in accordance with The Austrian Tribology Society as the publisher who is not responsible for any statement in this publication. This applies similarly to the editors.

6th Vienna International Conference

NANO-TECHNOLOGY
Focus: Tribological Aspects

VALUE-BASED MICRO- AND NANOTRIBOLOGY

Ille C. Gebeshuber
Aramis Technologies, Puchong, Selangor, Malaysia &
Vienna University of Technology, Institute of Applied Physics, Wien, Austria
gebeshuber@iap.tuwien.ac.at, ille.gebeshuber@mac.com

Biomimetics, global challenges, innovision, sustainable engineering, values in science.

1 Introduction

"*We can't solve problems by using the same kind of thinking we used when we created them.*"

Albert Einstein

Our view of the environment has changed from regarding it as a constant that provides resources and acts as a sink for waste towards a more complex view, where the environment is seen as a variable that can be influenced by our activities [1,2] (industrialization, species extinction, potential collapse of the marine ecosystem, global challenges) and on which we are utterly dependent. In this regard also micro- and nanotribologists, and more generally, in nanotechnologists, increasingly develop and apply green and potentially sustainable approaches. Some of them are disruptive, aiming at a new way of engineering that is good for all life, not just selected humans or human collectives.

The great advantage of micro- and nanotribologists is that they come from various fields, such as physics, mathematics, engineering, materials science, chemistry, biology and management as well as business sciences, and therefore thinking across borders may be easier for them than for the specialists scientists now bred in various other fields (where the current incentive systems are based on raising grants and publishing as many ISI rated publications as possible, already early in their career), enabling them to develop, accept and realize broader concepts in their work, paving the way towards sustainable micro- and nanotribology.

2 Methods

Transdisciplinary knowledge integration [3] and innovision [4] are combined to address the transdisciplinary topic of value based micro- and nanotribology. Innovision is a new method developed by the author. It is characterised by the development of a new frame work of thinking that is the prerequisite for the provision of solutions.

3 Results

Results comprise a three-gaps approach highlighting pitfalls and potentials ways to bridge gaps (Fig. 1), and three exemplary technologies that provide tribologically optimised solutions. These technologies yield new approaches concerning materials, structures and processes, the three main areas that tribology is concerned with.

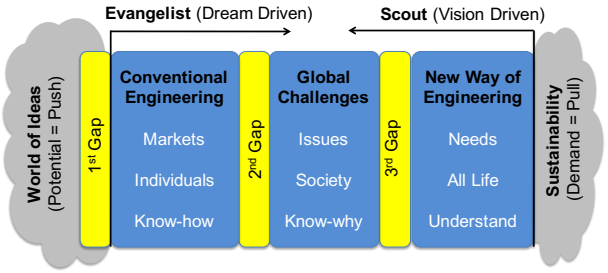


Figure 1: Engineering towards sustainability.

3.1 Materials: Phytomining – mining with plants – as inspiration for metal management for micro- and nanotribology

In current engineering approaches, metals are of paramount importance. Most of the metals are mined in environmentally unfriendly ways.

Phytomining, i.e. mining with plants via hyperaccumulation of metals in plants, is a local metal sequestration performed by plants and microorganisms without the drawbacks of conventional mining [5]. Various metals such as thallium, nickel, cadmium, gold, copper and manganese can be mined with plants. Furthermore, plants excel at producing metal nanoparticles with reproducible narrow bandwidth of shape and size, much better than most current manmade approaches.

3.2 Structures: Tribologically optimized functional micro- and nanostructures inspired by organisms

"Structure rather than material" is a principle that is commonly used in organisms yielding functionalities such as low adhesion, self-cleaning properties and gradient wetting behaviour [6]. In the wing scales of certain butterflies, a combination of all these functionalities with colours that are produced by structures rather than pigments is realised. Instead of toxic chemicals, structures of materials that are benign when micro- and nanostructured can achieve the same if not better tribological functionalities than reached with conventional methods.

3.3 Processes: Biomineralized rigid micro- and nanoscale parts in relative motion

Biomineralization is the term for the production of minerals in organisms [7]. Organisms produce more than

70 different minerals, including ceramics, magnets and complex composites (Fig. 2). These biominerals have intriguing properties: they are produced at ambient conditions and are functional structures with elaborate material properties, regarding toughness, optical effects, electromagnetic behaviour and others.

The advantages of biomineralization over conventional material production are manifold. Normally, in human material synthesis, until the final product, various steps are necessary. The base materials need to be mined, put together, melted (at high temperatures) and are then pressed into shape. Biomineralisation works at ambient conditions, with proteins guiding the whole process and little or no waste.

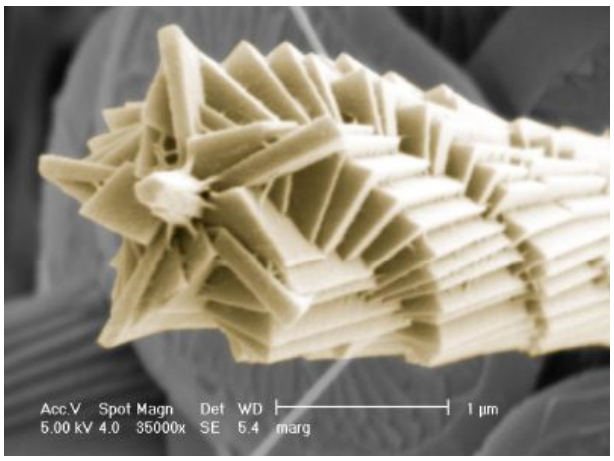


Figure 1 Example for integration of structures, materials and processes in the microorganism Rhabdosphaera clavigera*. The spine tip material is calcite ($CaCO_3$). Its structure is a spiral formed from consistently aligned crystal units with rhombic faces. The process yielding this structure is biomineralization with the help of proteins in cool seawater, at ambient conditions. Scale bar 1 µm = 0.001 mm. From [8], permission pending.*

4 Discussion and Outlook

The findings presented here shall ultimately yield recommendations on how to propel micro- and nanotribology forward towards sustainability.

It is suggested that we deeply think about how we could start a completely new, revolutionary, disruptive way of doing tribology, in collaboration with life around us. It is doable, and necessary, given the huge damage that has arisen until now due to activities of modern, technological human societies. Our knowledge in biomimetic engineering and in nanoscience and nanotechnology, which work on the same scale as the language of life and are similarly powerful, will support us in developing and establishing a new, sustainable way – for the well being of all.

Questions that however need to be addressed are: How to implement values in our teachings and breed a new type of scientist who cares also for our common future and not just for individual happiness, which might require a completely different framework?

Are we aware of the problems of interdisciplinary approaches (harder to get money, harder to get reviewers)? Do we inform our students about it? What are we doing to address this?

Future attempts in the transdisciplinary area of inspiration for value based micro- and nanotribology shall include concise definition of the problems the field is currently facing, with a summary of the most pressing issues, and ideas on what can be done to successfully address them, as micro- and nanotribologists with visions, missions and goals.

5 References

[1] J. Rockström, W. Steffen, K. Noone, Å. Persson, F. S. Chapin III, E. F. Lambin, T. M. Lenton, M. Scheffer, C. Folke, H. J. Schellnhuber, B. Nykvist, C. A. de Wit, T. Hughes, S. van der Leeuw, H. Rodhe, S. Sörlin, P. K. Snyder, R. Costanza, U. Svedin, M. Falkenmark, L. Karlberg, R. W. Corell, V. J. Fabry, J. Hansen, B. Walker, D. Liverman, K. Richardson, P. Crutzen and J. A. Foley: A safe operating space for humanity. Nature 461, 472-475, 2009.

[2] W. Steffen, K. Richardson, J. Rockström, S. E. Cornell, I. Fetzer, E. M. Bennett, R. Biggs, S. R. Carpenter, W. de Vries, C. A. de Wit, C. Folke, D. Gerten, J. Heinke, G. M. Mace, L. M. Persson, V. Ramanathan, B. Reyers and S. Sörlin: Planetary boundaries: Guiding human development on a changing planet. Science 347, 6223, 2015.

[3] J. Godemann: Knowledge integration: a key challenge for transdisciplinary cooperation. Environ. Educ. Res. 14(6), pp. 625-641, 2008.

[4] I. C. Gebeshuber: Value based science: What we can learn from micro- and nanotribology. Tribology - Materials, Surfaces and Interfaces, in press. doi:10.1179/1751584X15Y.0000000008.

[5] S. B. Karman, S. Z. M. Diah and I. C. Gebeshuber: Raw materials synthesis from heavy metal industry effluents with bioremediation and phytomining: A biomimetic resource management approach. Adv. Mat. Sci. Eng. 185071(21pp), 2015.

[6] I.C. Gebeshuber, B.Y. Majlis and H. Stachelberger: Biomimetics in Tribology. In: Biomimetics - Materials, Structures and Processes. Examples, Ideas and Case Studies, Springer, pp. 25-50, 2011.

[7] S. Mann: Biomineralization. Oxford University Press, 2002.

[8] J.R. Young, and K. Henriksen: Biomineralization within vesicles: The calcite of coccoliths. Biomineralization, Reviews in Mineralogy and Geochemistry, Nr. 54, Mineralogical Society of America, 2003.

Exhibitors (Viennano '15 and ÖTG-Symposium 2015):
(in alphabetical order)

AC2T research GmbH
Wiener Neustadt, AT
www.ac2t.at

Alicona Imaging GmbH
Raaba/Graz, AT
www.alicona.at

Anglo-Euro Scientific
Nottingham, UK
www.angloeuro.co.uk

Anton Paar GmbH
Graz, AT
www.anton-paar.com

Klüber Lubrication Austria Ges.m.b.H.
Salzburg, AT
www.klueber.com/at

NT-MDT
Castleroy, Limerick, IE
www.ntmdt.eu

Technopol Wiener Neustadt
Wiener Neustadt, AT
www.technopol-wienerneustadt.at

Tribotron AG
St. Gallen, CH
www.tribotron.com

Phoenix Tribology Ltd
Kingsclere, UK
www.phoenix-tribology.com

We ACT for reliability !

www.oetg.at **office@oetg.at**

ÖSTERREICHISCHE TRIBOLOGISCHE GESELLSCHAFT

Wissenschaftlicher Verein

Arbeitsgemeinschaft für Reibungs-, Verschleiß- und Schmierungstechnik

A 2700 Wiener Neustadt, Viktor-Kaplan-Str. 2/C, Tel. +43 (0)676 845162 300, Fax +43 (0)1 2533 033 9100

ISBN 978-3-901657-52-8