TECHNISCHE UNIVERSITÄT WIEN

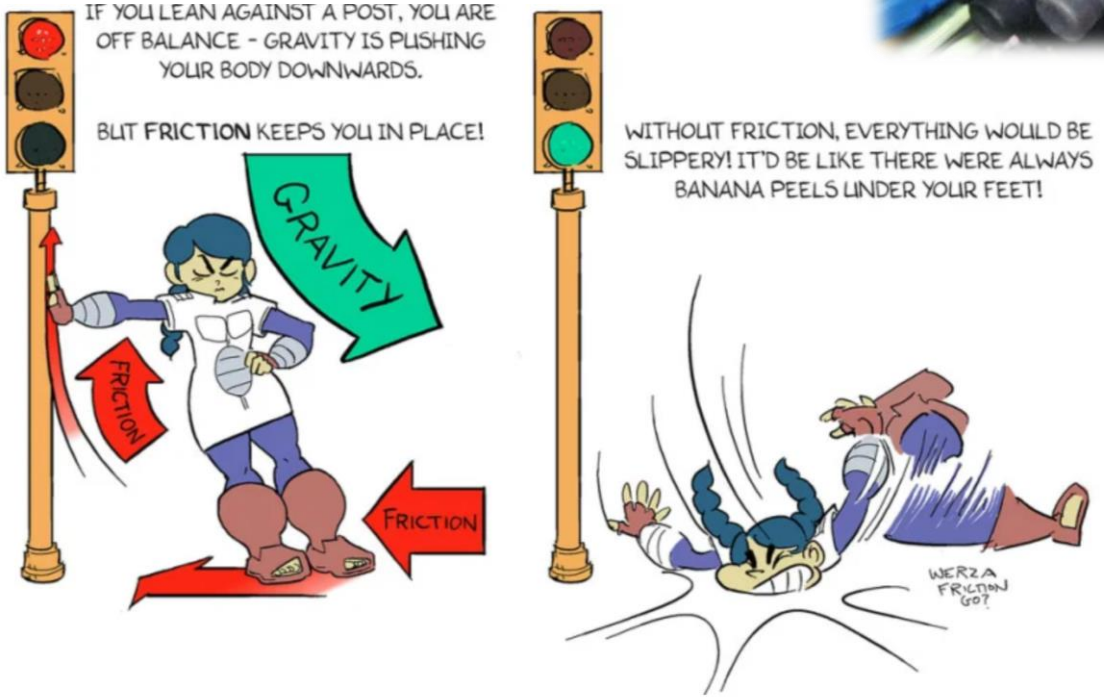
“Tailored Engineering Surfaces and Novel 2D Materials for Friction- and Energy Reduction”

Univ.-Prof. Dipl.-Ing. Dr.-Ing. Carsten Gachot

Head of the Tribology Research Unit E307-05 @ **TU WIEN**

17th International Eco-Mobility Conference by A3PS, 25.11.2022

Friction – the good “cop”/bad “cop”

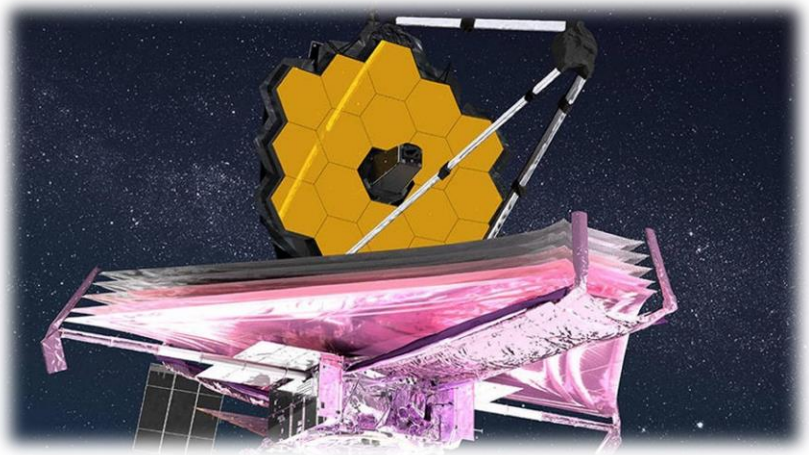


Relevance of Tribology

TECH

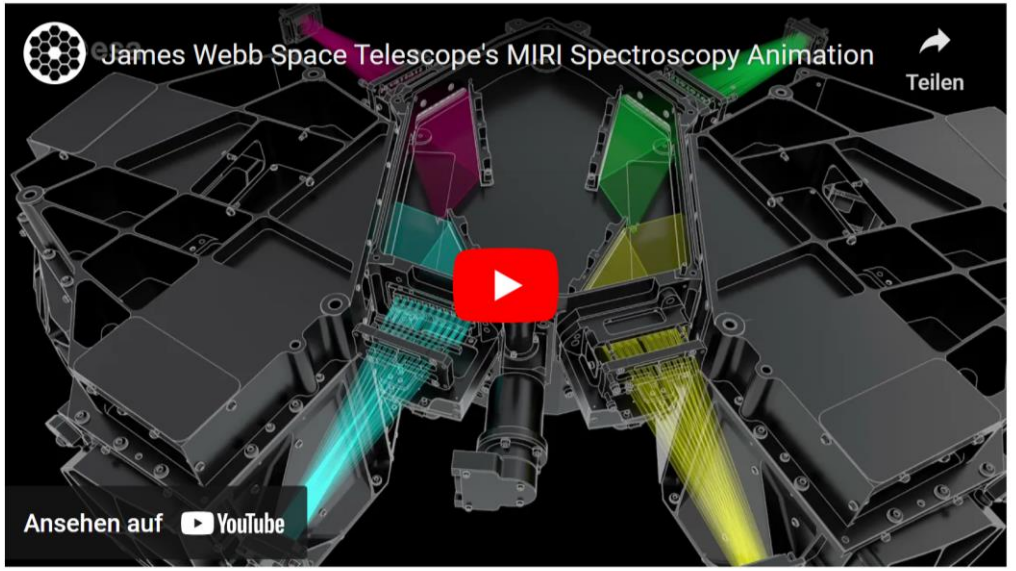
James Webb telescope has a friction drawback that NASA wants to repair

BY BHAGYASHREE SONI – SEPTEMBER 22, 2022 – UPDATED: SEPTEMBER 22, 2022 NO COMMENTS 2 MINS READ



"Erhöhte Reibung" bei Gitterrad

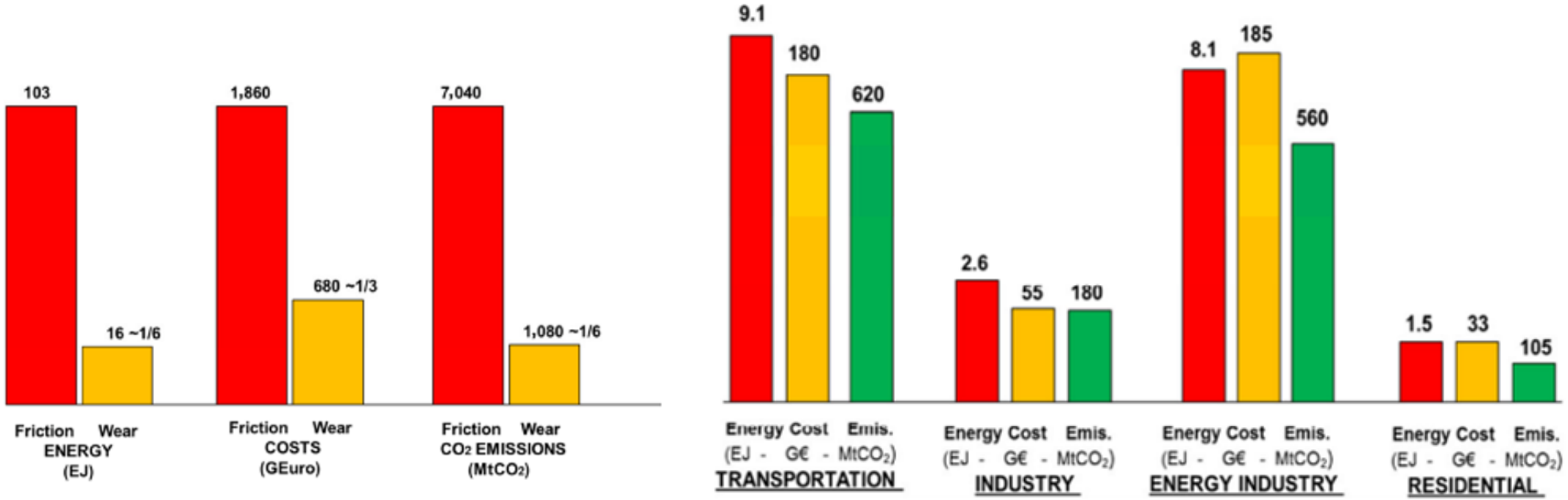
In einer ***Aussendung*** spricht die Weltraumorganisation von “erhöhter Reibung” eines **Gitterrades**, einer Art Zahnrad, das es Forscher*innen ermöglicht, bei ihrer Beobachtung zwischen kurzen, mittleren und langen Wellenlängen zu wechseln.



D IRI hat insgesamt **4 Beobachtungsmodi**, durch den Defekt sei die “ auflösende Spektroskopie” vorerst aber nicht mehr möglich. Die NASA

Relevance of Tribology

Energy, costs and CO_2 emissions worldwide 2017 due to friction & wear!

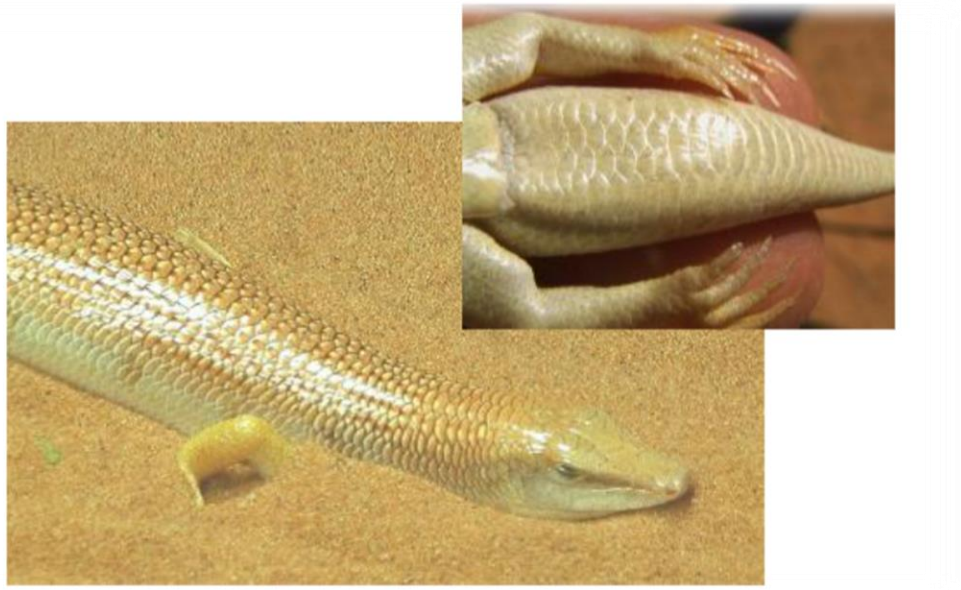


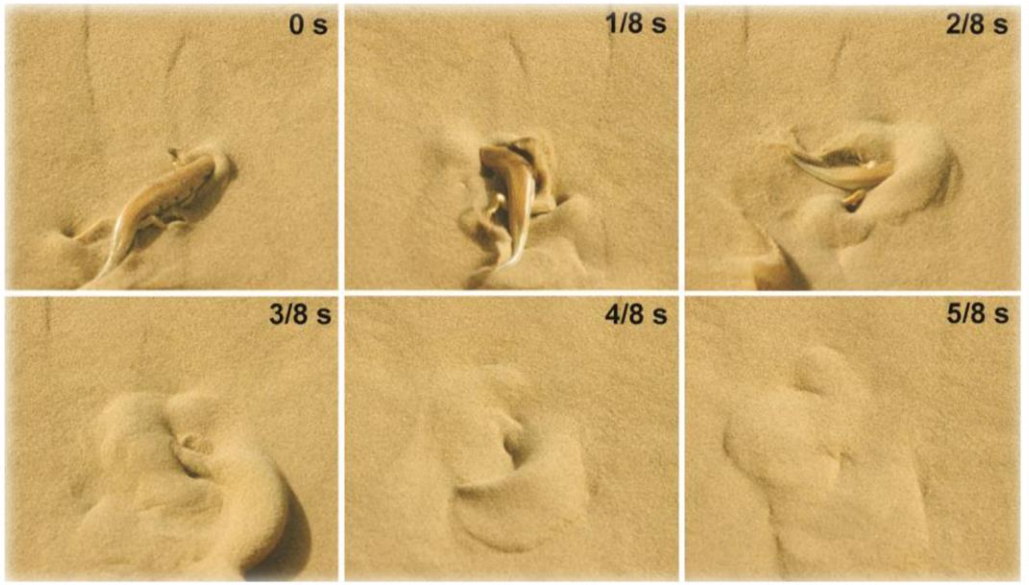
Holmberg, K., & Erdemir, A. (2017). Influence of tribology on global energy consumption, costs and emissions. Friction, 5(3), 263-284.

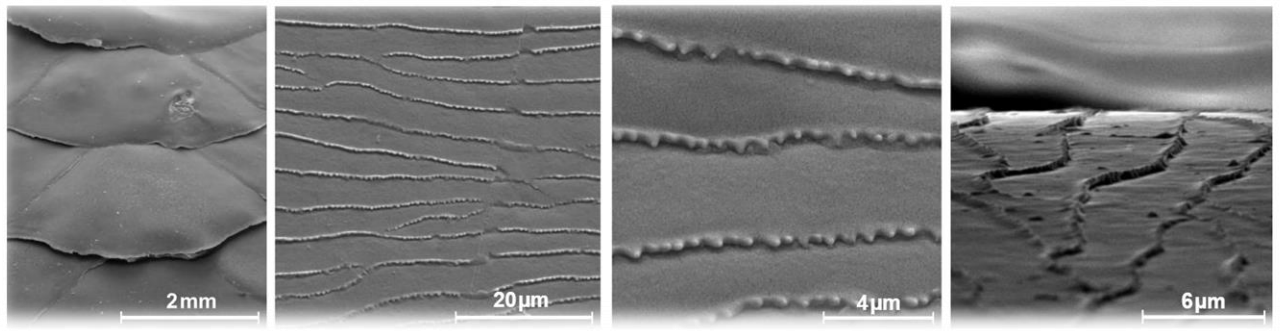
I. Advanced Surface Engineering

Inspired by nature!

Sandfish skink

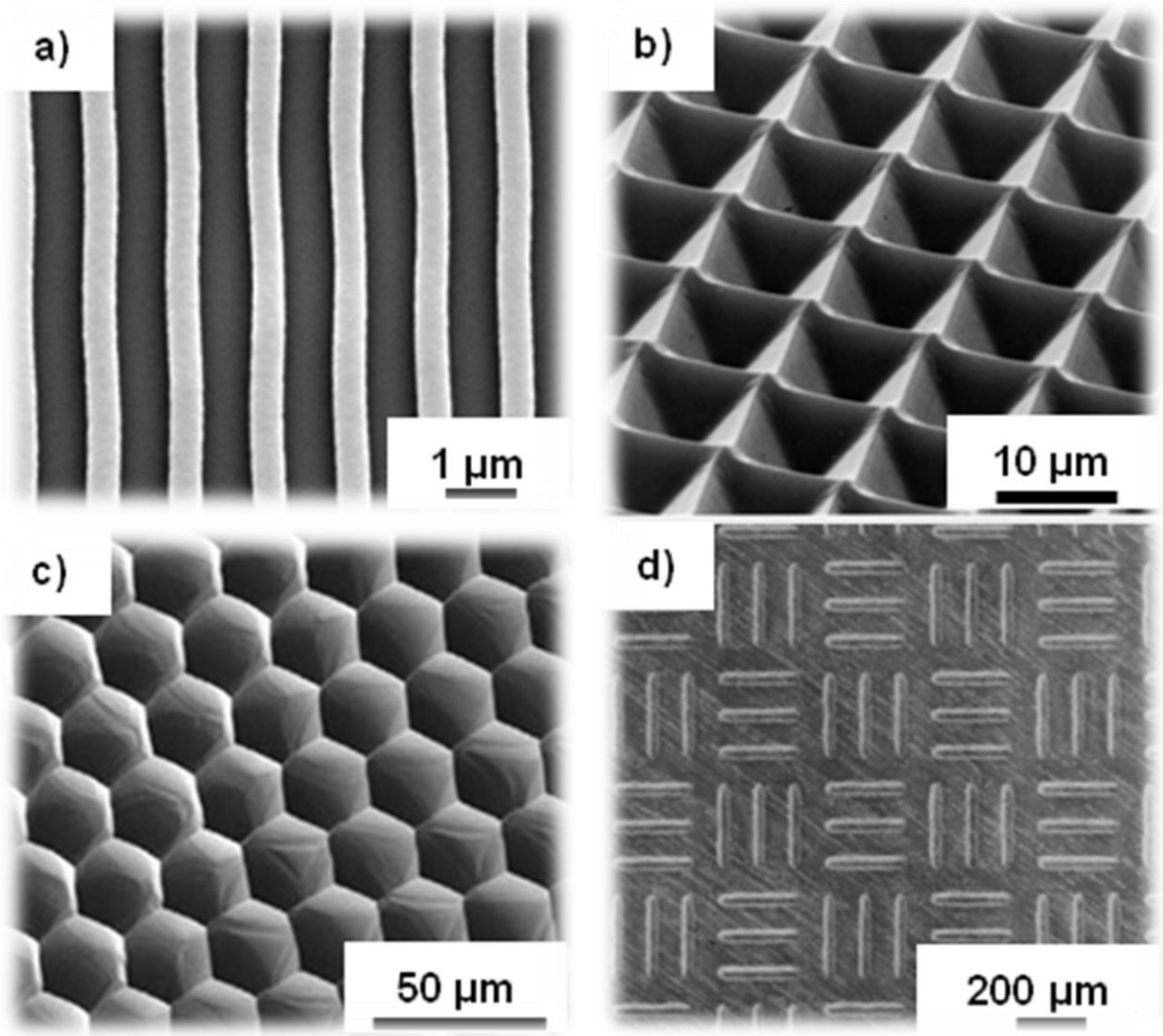






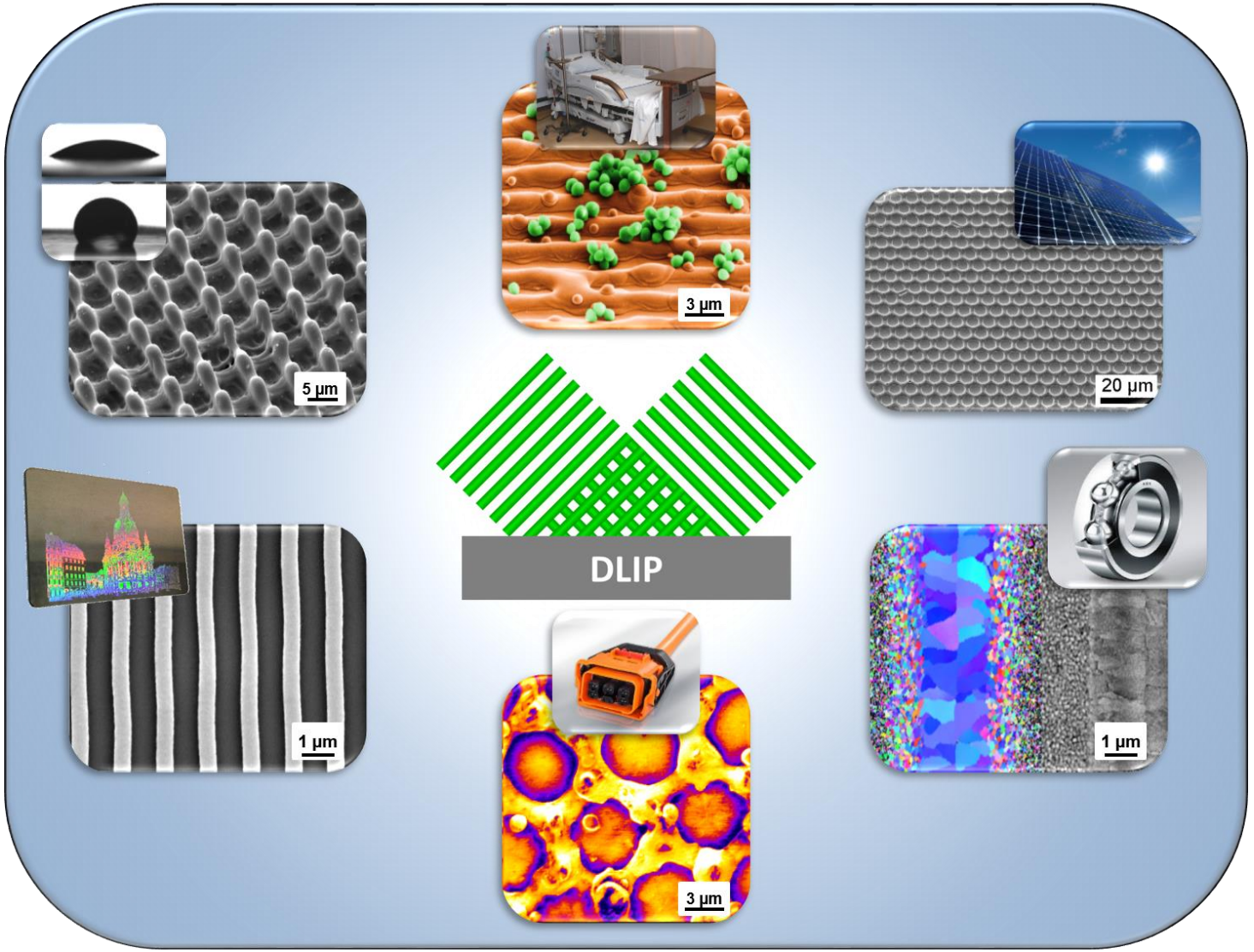
Schlussbericht, BMBF, Förderkennzeichen 0311967A, Ingo Rechenberg, TU Berlin

Some tailored surfaces made by engineers…



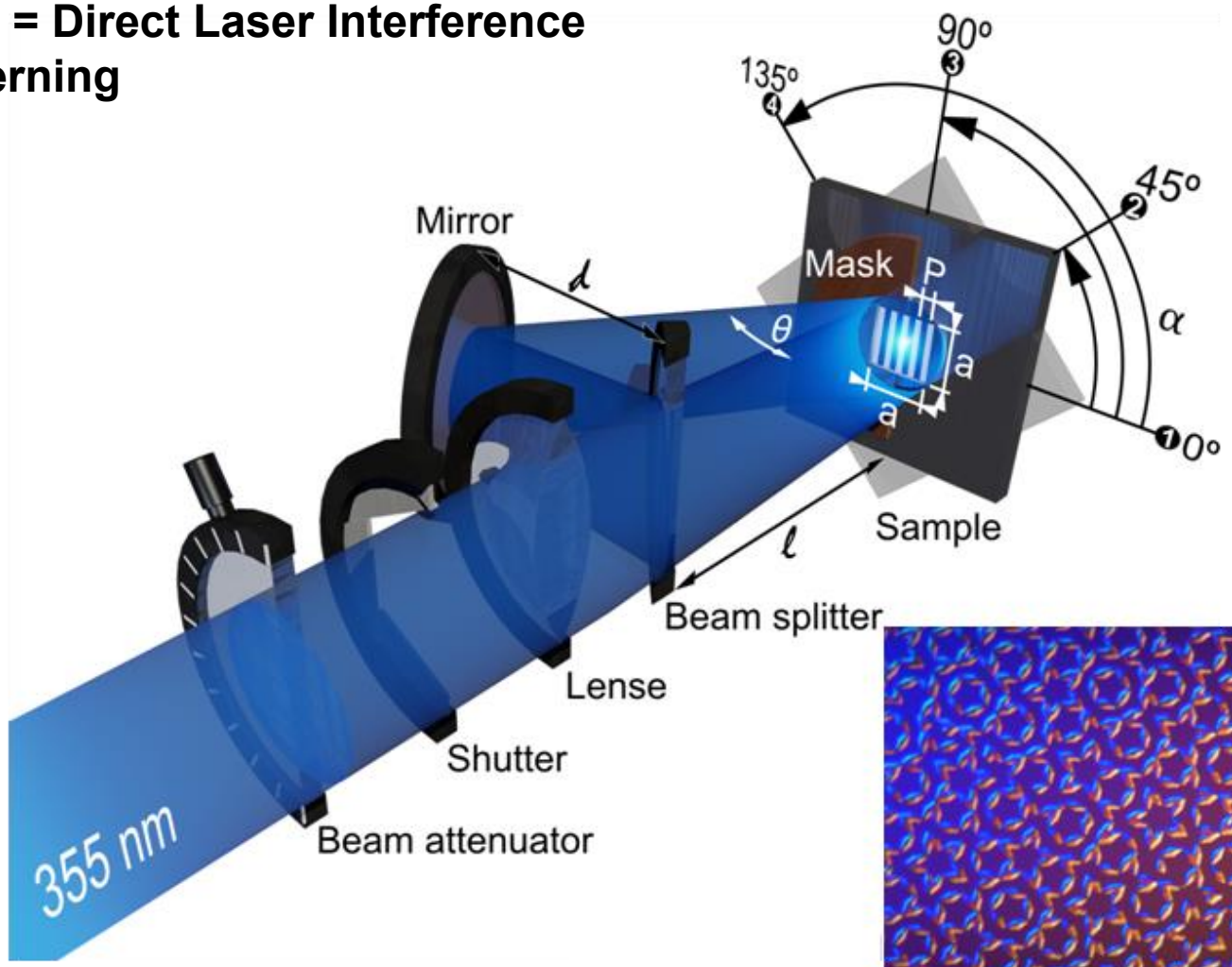
C. Gachot, A. Rosenkranz, S.M. Hsu, H.L. Costa, A critical assessment of surface texturing for friction and wear improvement, Wear, Volumes 372–373, 2017, Pages 21-41.

Applications of textured surfaces?



Using an „old“ physical principle…

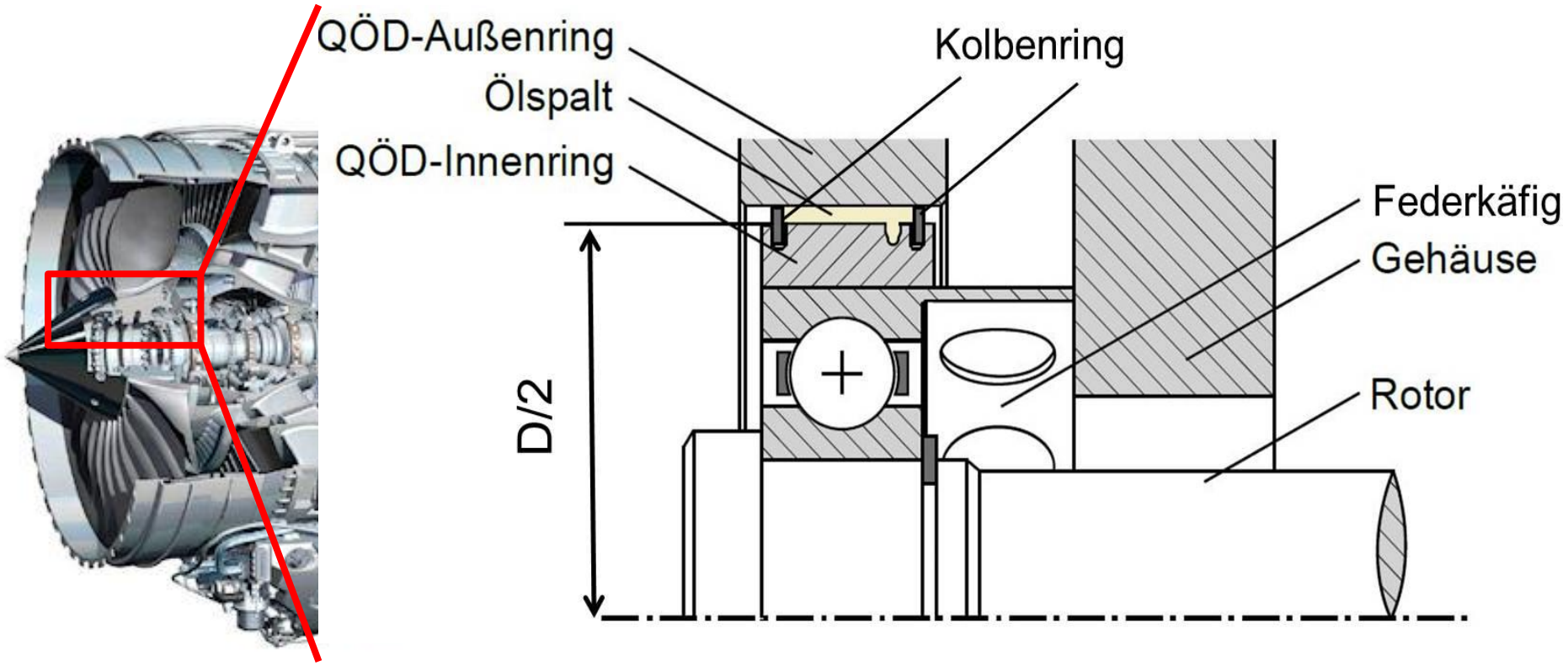
DLIP = Direct Laser Interference Patterning



Penrose tiling

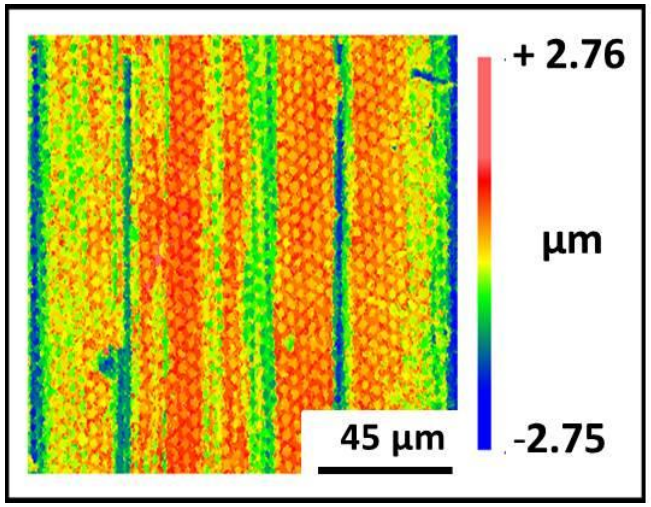
Gachot et al., Applied Surface Science, 2016

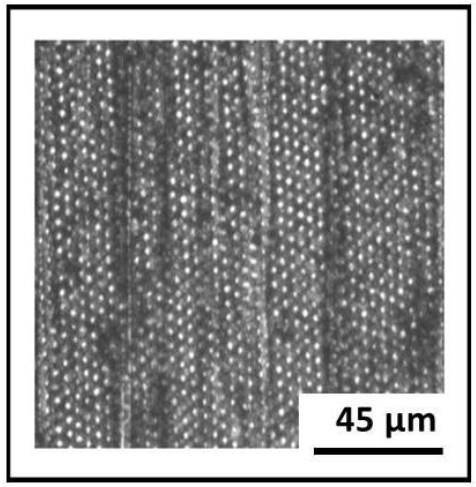
Piston rings of squeeze film dampers

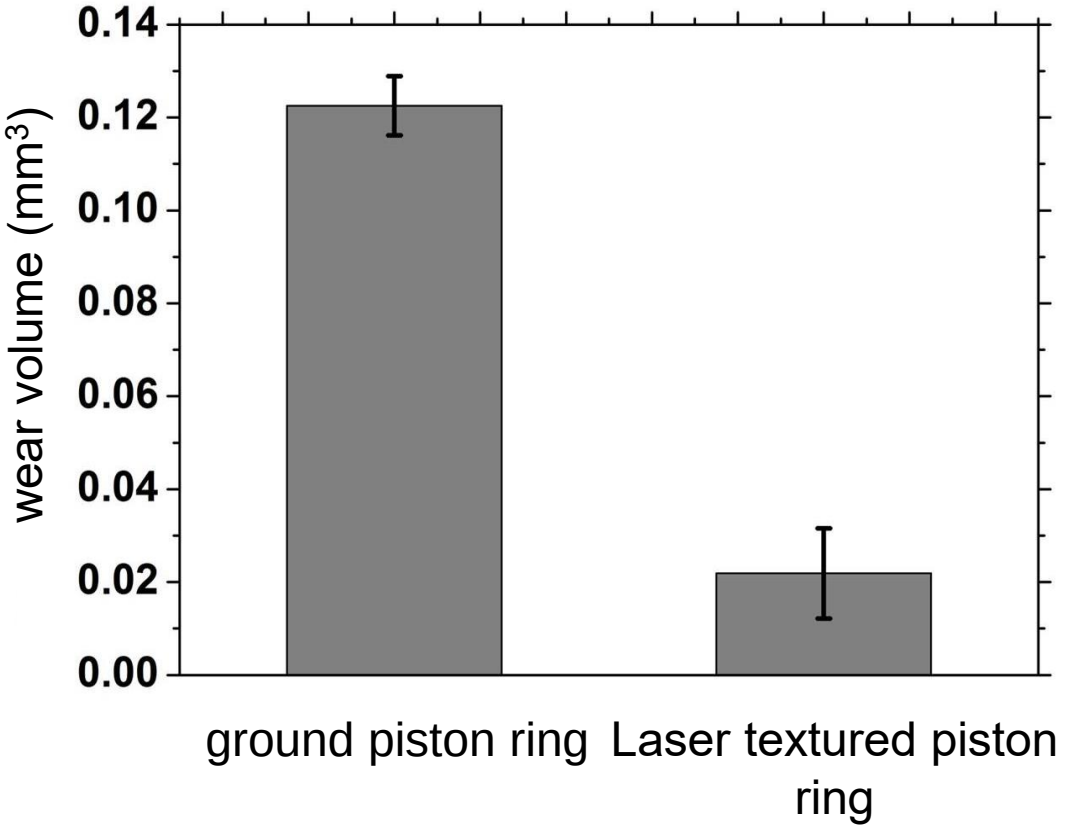


Using surface texturing in highly loaded components

Piston rings of squeeze film dampers in turbines







wear reduction by a factor of 6!

Surface texturing of electrical connectors

Strongly enhanced reliability required

Car Breakdown Statistics

(ADAC Germany, 2014)

- **Electrical system: 46 %**
- Motor management: 16 %
- Engine: 7 %
- Fuel system: 5 %
- Air conditioning: 4 %
- Miscellaneous 21 %

60 kg

lines: 3100 m

No. of connecting lines: 1745

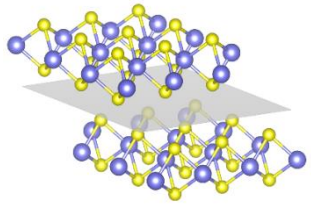
No. of electrical connectors: 3500

No. of contact housings: 671

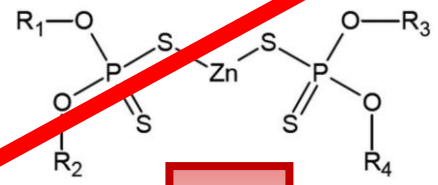
→ + autonomous driving!

II. High-Performing Solid Lubricants – 2D Materials

How to anticipate friction & wear? – New coating concepts



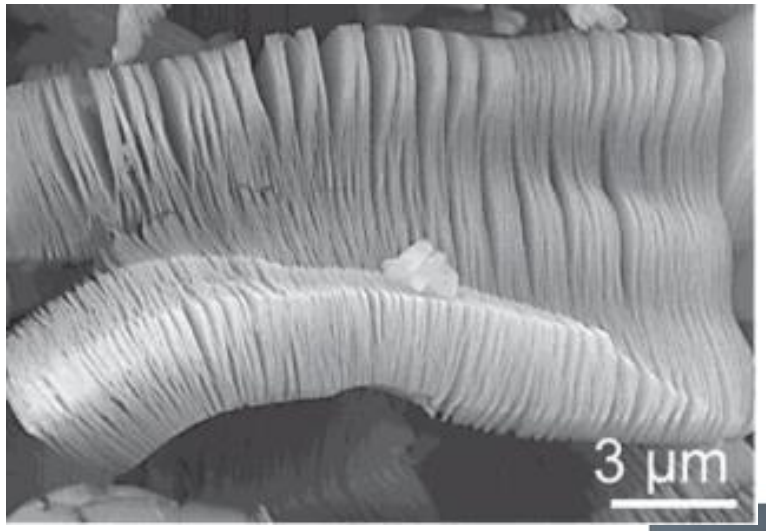
Zinc dialkyl dithiophosphates (ZDDP)

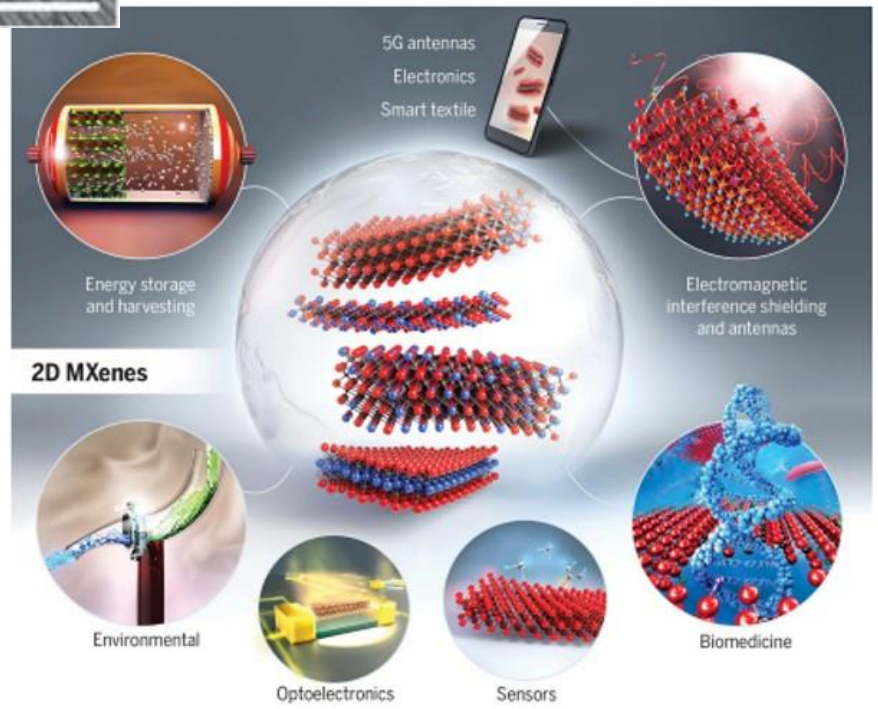


- ***TiN, TiAlN, TiCrN, Al_2O_3***
- ***DLC, Transition metal nitrides and carbides***
- ***Lubricating coatings, 2D materials (WS_2, MoS_2, Graphene, MXenes etc.)***

[1] World Energy Council; Global Transport Scenarios 2050; 2011
[2] Chu S, Majumdar A.; Opportunities and challenges for a sustainable energy future; Nature 2012
[3] Spikes H.; The History and Mechanisms of ZDDP; Tribology Letters 2004
[4] Erdemir A, Donnet C.; Tribology of diamond-like carbon films: recent progress and future prospects; Journal of Physics D: Applied Physics 2006

A new “family” of materials – MXenes as 2D materials





DERSTANDARD › Wissenschaft SUPPORTER

24 Postings

Neues 2D-"Wundermaterial" ist der perfekte Schmierstoff

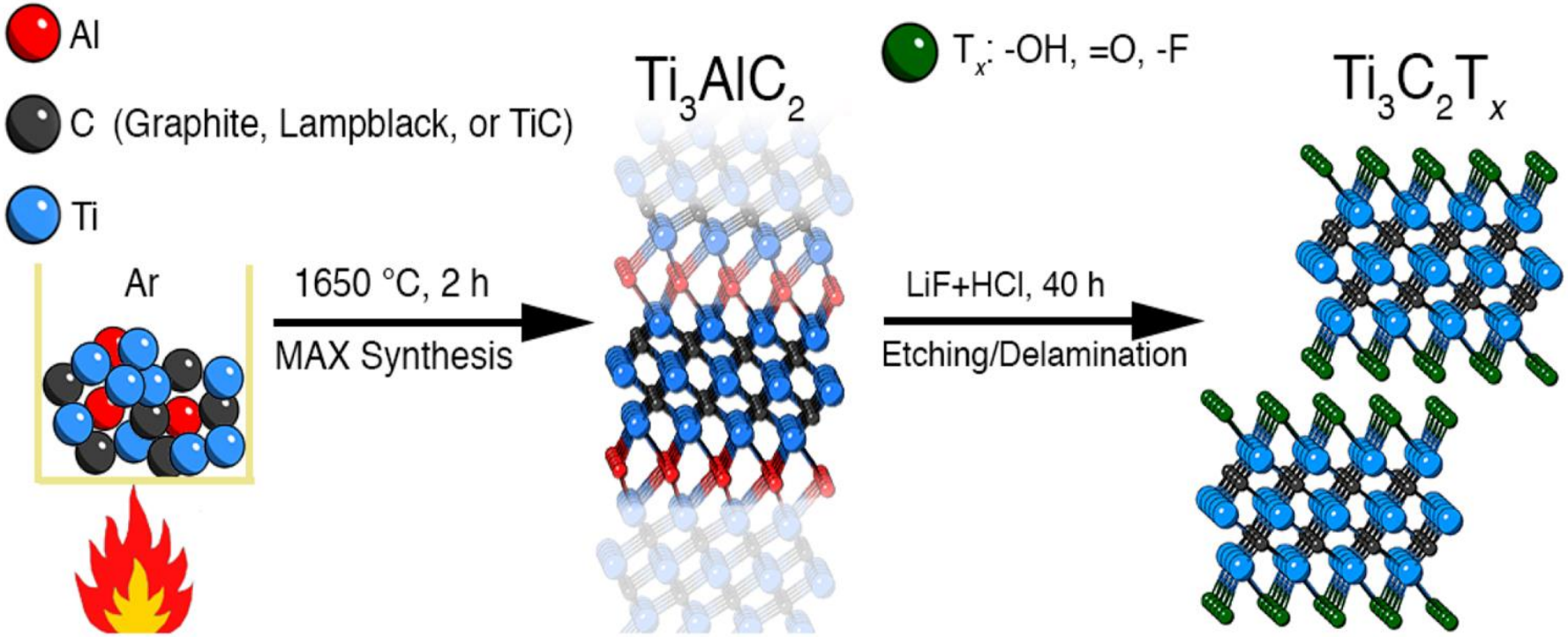
Das Nanomaterial mit vielversprechenden Eigenschaften eignet sich als Festschmiermittel unter extremen Bedingungen

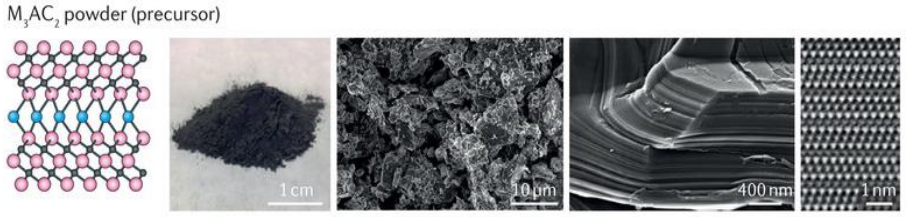
21. April 2021, 08:12 24 Postings

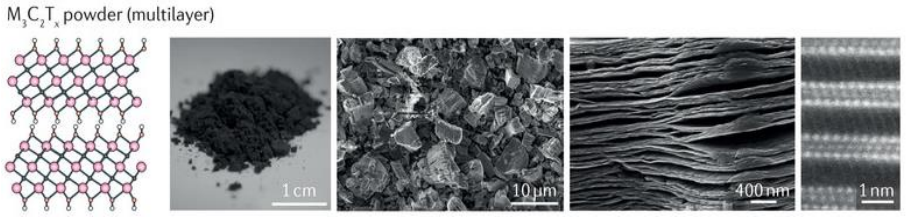
Nicht zuletzt den Errungenschaften der Materialwissenschaft ist es zu verdanken, dass die Bezeichnung "Wundermaterial" mittlerweile inflationär verwendet wird. Auch die Materialklasse der sogenannten MXene (sprich: Maxene) bekam schon häufig dieses Schild umgehängt. Und tatsächlich zeigt das zweidimensionale Nanomaterial vielversprechende Eigenschaften etwa für den Einsatz in der Energiespeicherung. Wiener Forscher berichten nun im Fachjournal "ACS Nano", dass sich MXene auch als hervorragende Schmierstoffe erwiesen haben, die extrem haltbar sind und auch unter schwierigsten Bedingungen funktionieren.

Wie das Kohlenstoff-Material Graphen zählen auch die MXene zu den sogenannten 2D-Materialien: Ihre Eigenschaften werden wesentlich dadurch bestimmt, dass es sich um ultradünne Schichten handelt, um einzelne Atomlagen, ohne starke Bindungen nach oben oder unten.

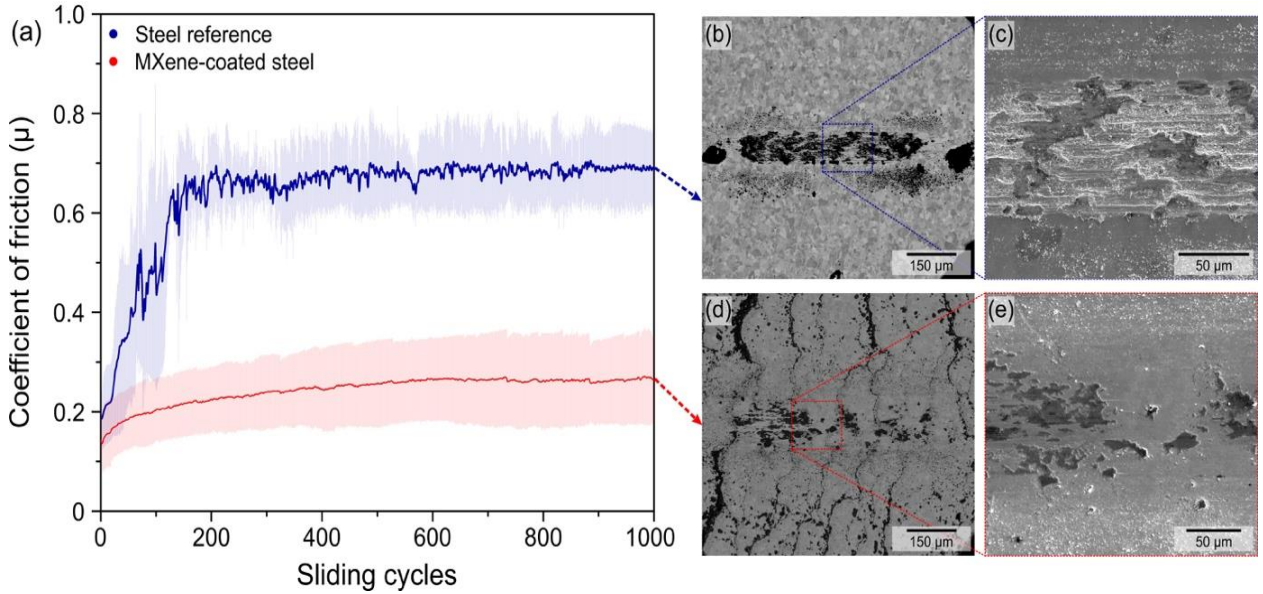
MXenes - synthesis

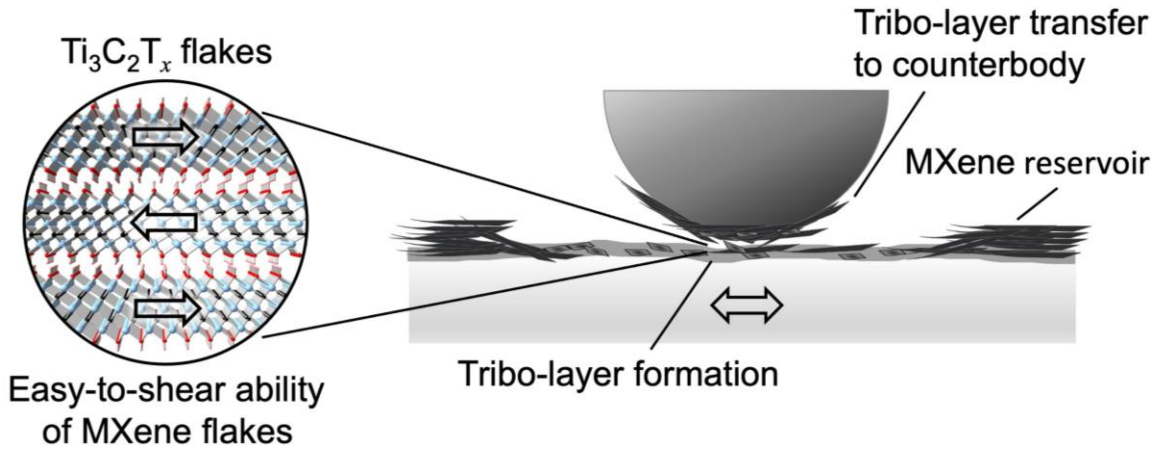


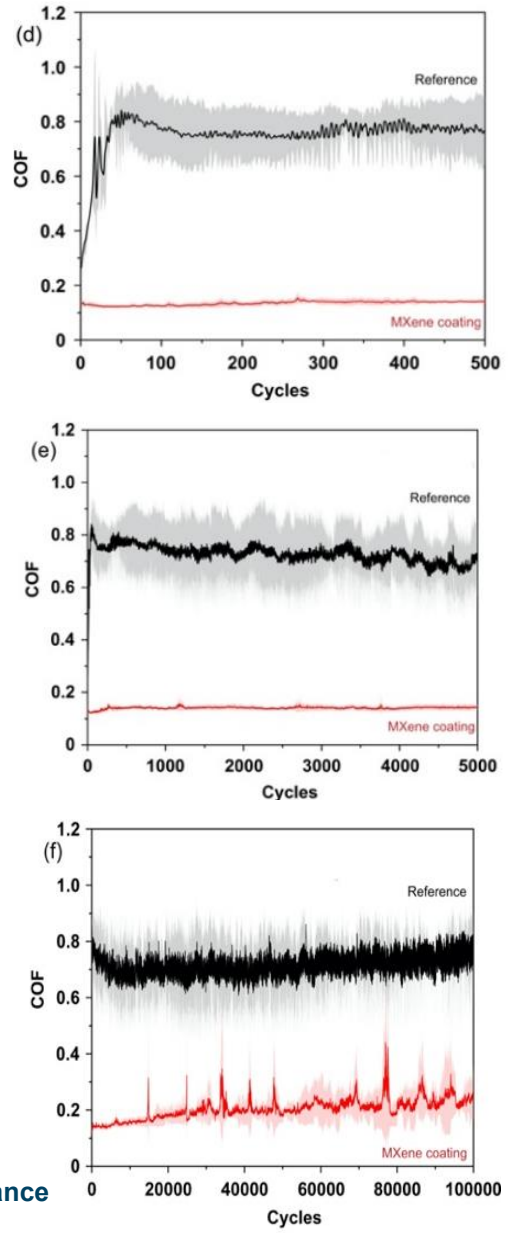




Friction & wear properties of MXenes







Grützmacher, P. G., Suarez, S., Tolosa, A., Gachot, C., Song, G., Wang, B., ... & Rosenkranz, A. (2021). Superior Wear-Resistance of $Ti_3C_2T_x$ Multilayer Coatings. *ACS nano*.

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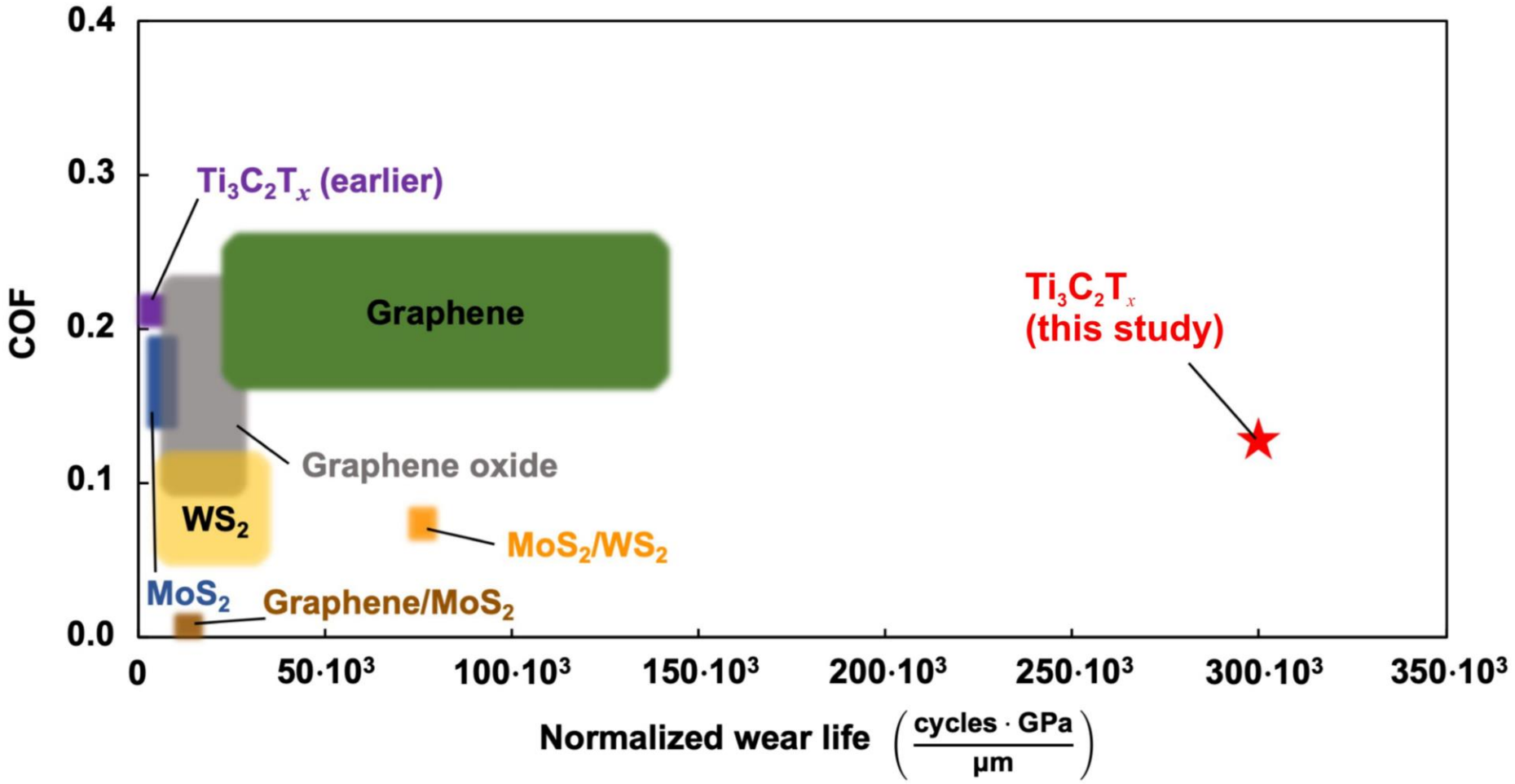

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Thanks for your kind attention!

Contact details:

Univ.- Prof. Dr.-Ing. Carsten Gachot
Institute for Engineering Design and Product Development E307, **Tribology Research Unit**
TU Wien
Lehárgasse 6, 1060 Vienna, Austria
Phone: +43 (1)58801-30763
carsten.gachot@tuwien.ac.at
http://www.ikl.tuwien.ac.at/tribologie/

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