UNIVERSITÄT DES SAARLANDES

Chair of Functional Materials

Introducción y motivación
Caracterización de Materiales

University of California San Diego

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Alexander von Humboldt Stiftung/Foundation

My background…

Study **Materials Science** and **Engineering**

10/2005

PhD-thesis **Tribology** and **Surface Engineering**

12/2010

PhD-Defense

01/2015

Tribology on hard coatings Catholic University Santiago de Chile

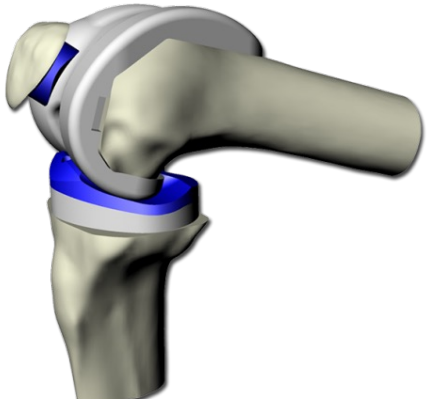
03/2015

Tribology in magnetic disks University of California (**Feodor-Lynen Fellow**)

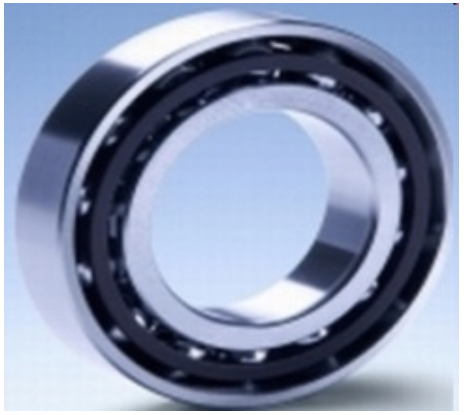
11/2016

Alexander von Humboldt
Stiftung/Foundation

Friction and wear – daily phenomena



What do all these objects have in common?



Sources: contact lens: focus180.ch, lipstick: douglas.de, knee: biotribology.org, breaking pad: theonecar.com, gear pairing: www.hornet-design.de/org/zahnradpaar, bearing: www.lineartechnik-korb.com/waelzlager_2.jpg

Current problems and future aspects

Fuel

40 l [1]

≈

50 $

F **Frictional losses** **%**

13 l ≈ 17 $

Used energy

8.5 l ≈ 11 $

To overcome frictional losses

- **340 l fuel per year and car** (approx. **450 USD** per car)
- Worldwide approx. **208 billion liter** of fuel per year

Future aspect:

- reduction of the **CO_2-emission** from 130 to 95 g/km

[1] Holmberg et al. Tribol. Int. 47 (2012)

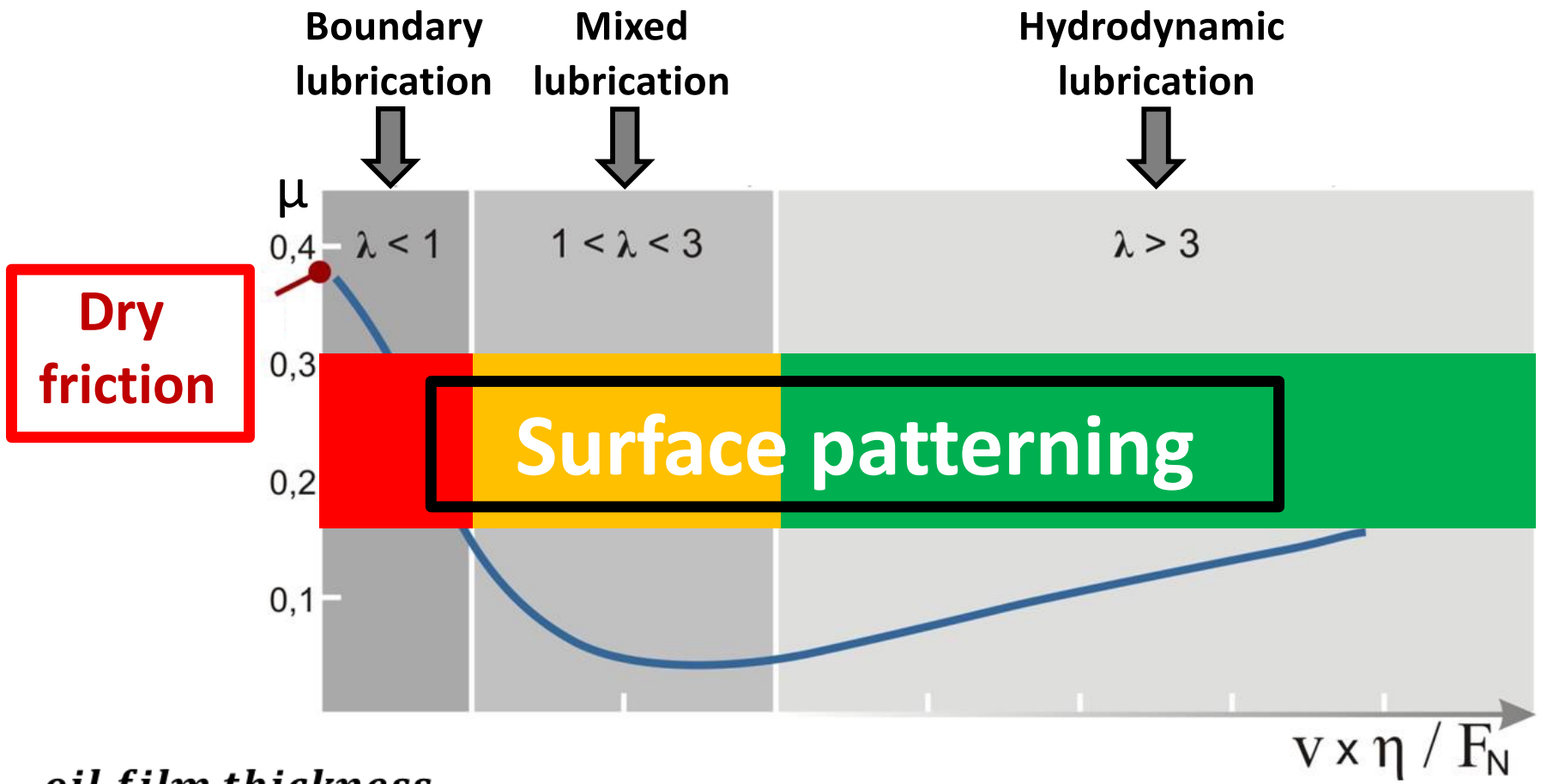
Sources: tires www.car-point.tv/images/getriebe1.png, engine: www.Auto-bild.de, breaking pad: theonecar.com

Tailoring of friction and wear by…

- Use of oil or solid lubricants
- Surface engine[illegible]tion
- Application of

The problem with the oil…

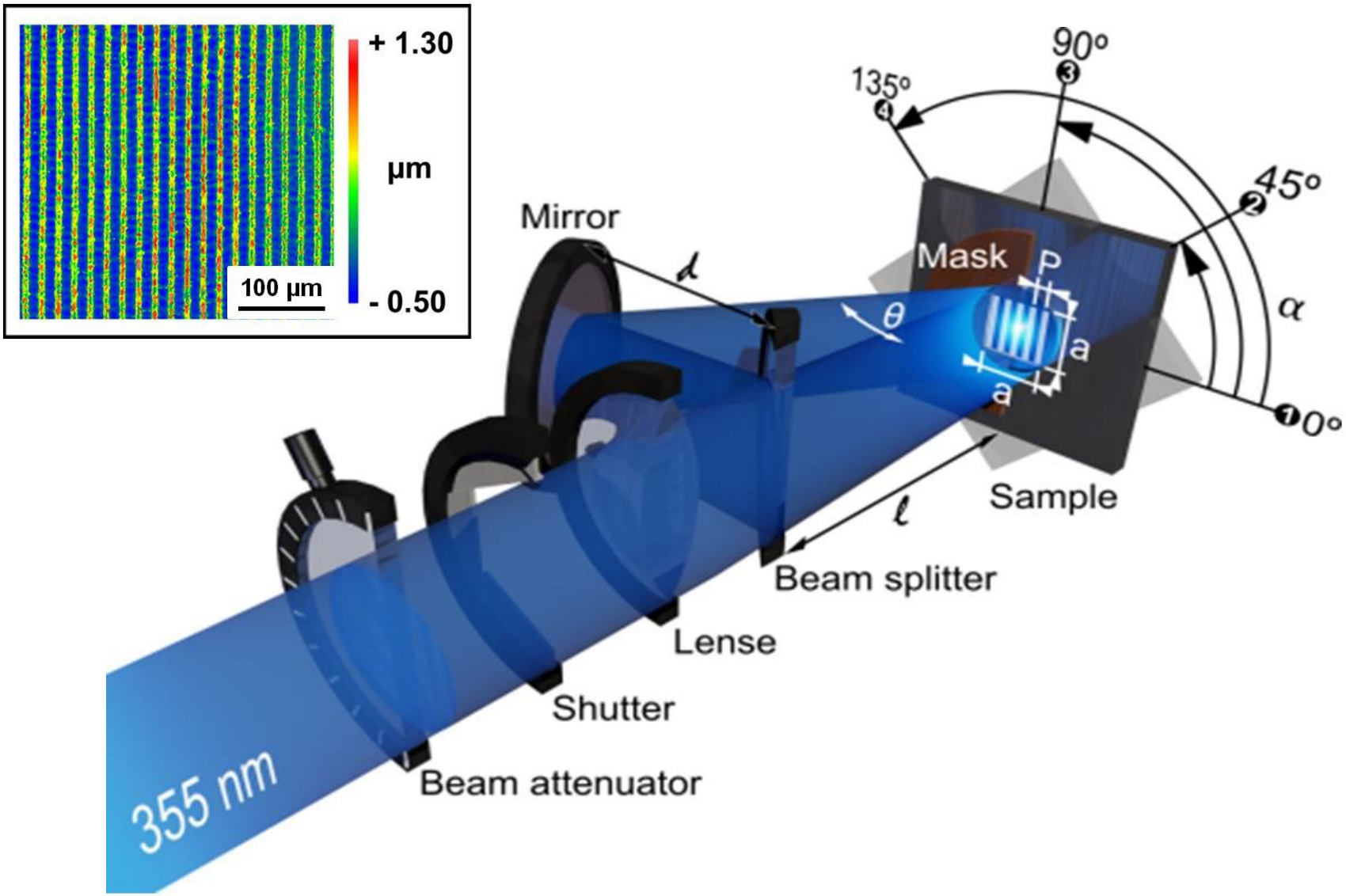
- **Use of oil**



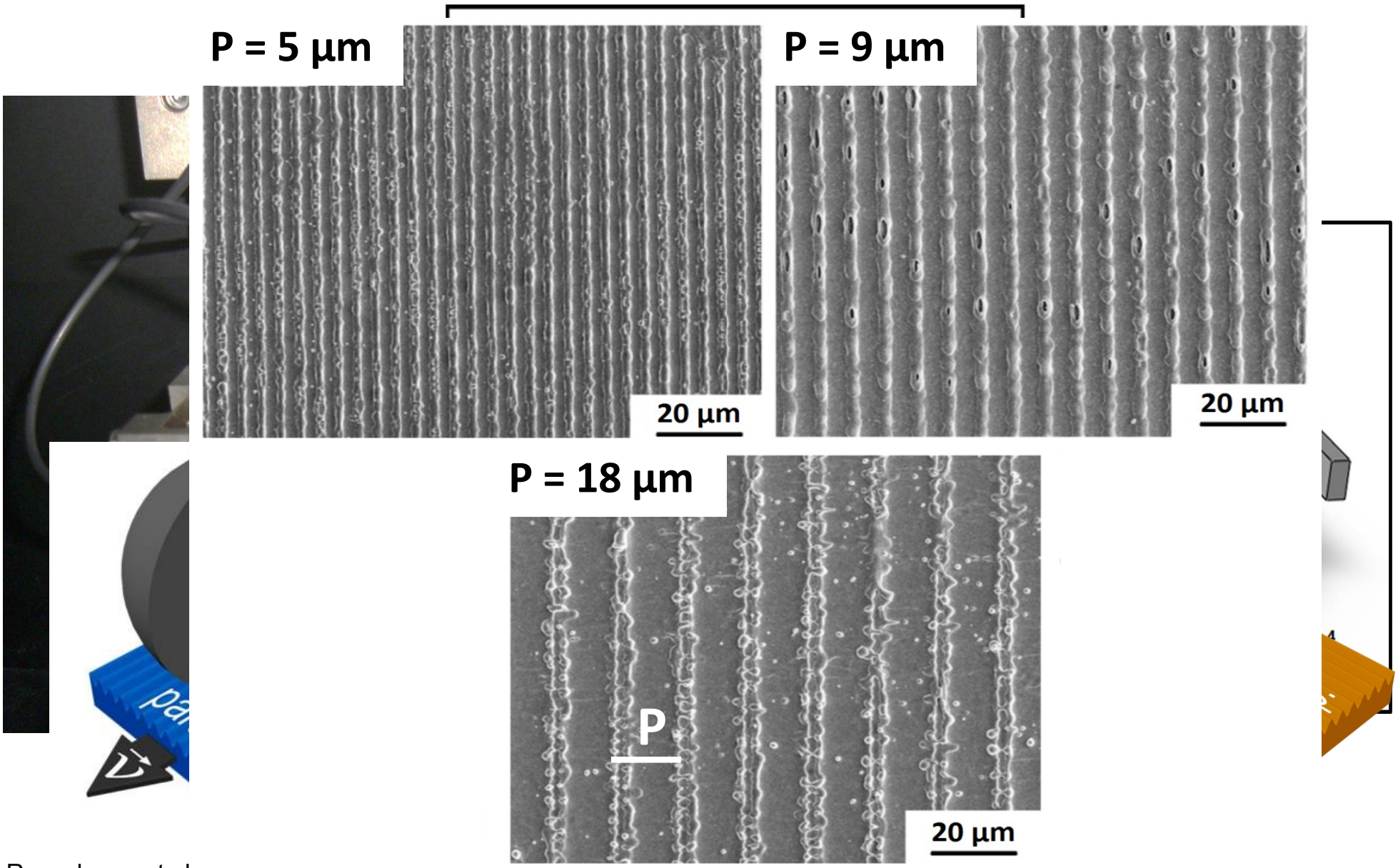
$$\lambda = \frac{oil\ film\ thickness}{surface\ roughness}$$

Surface engineering by…

Direct laser interference patterning

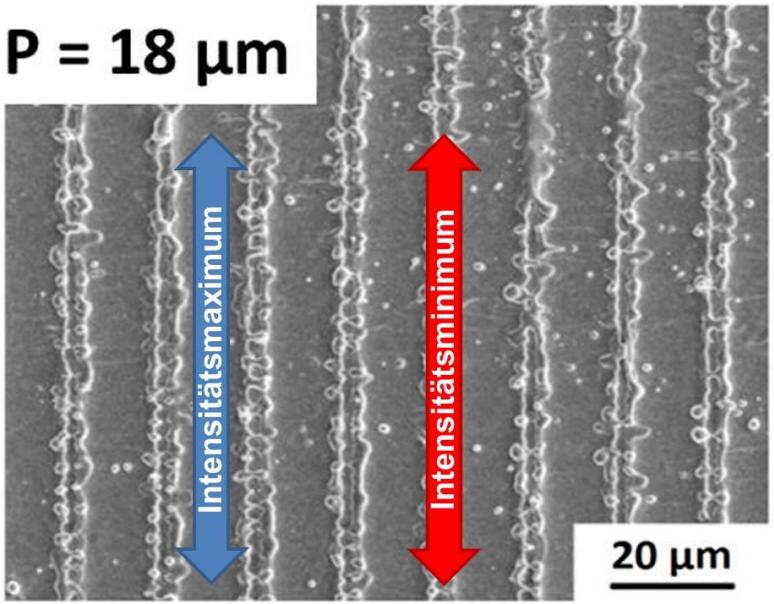


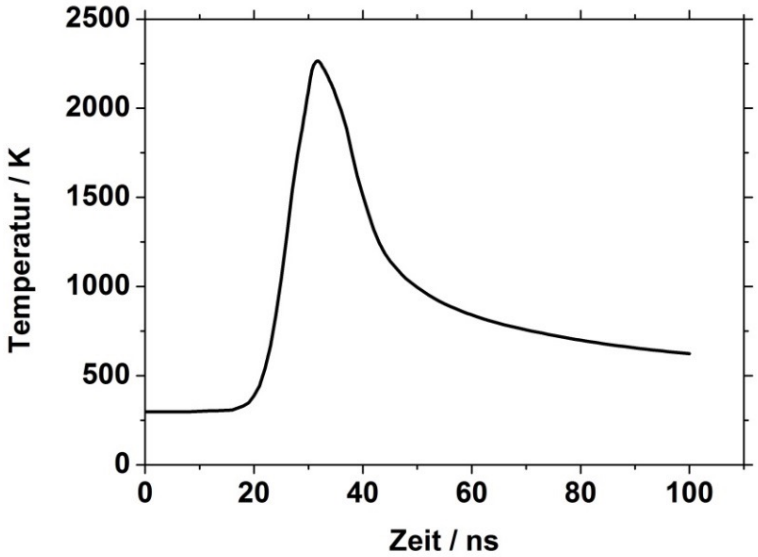
How to evaluate the frictional behavior of laser-patterned surfaces under dry friction…

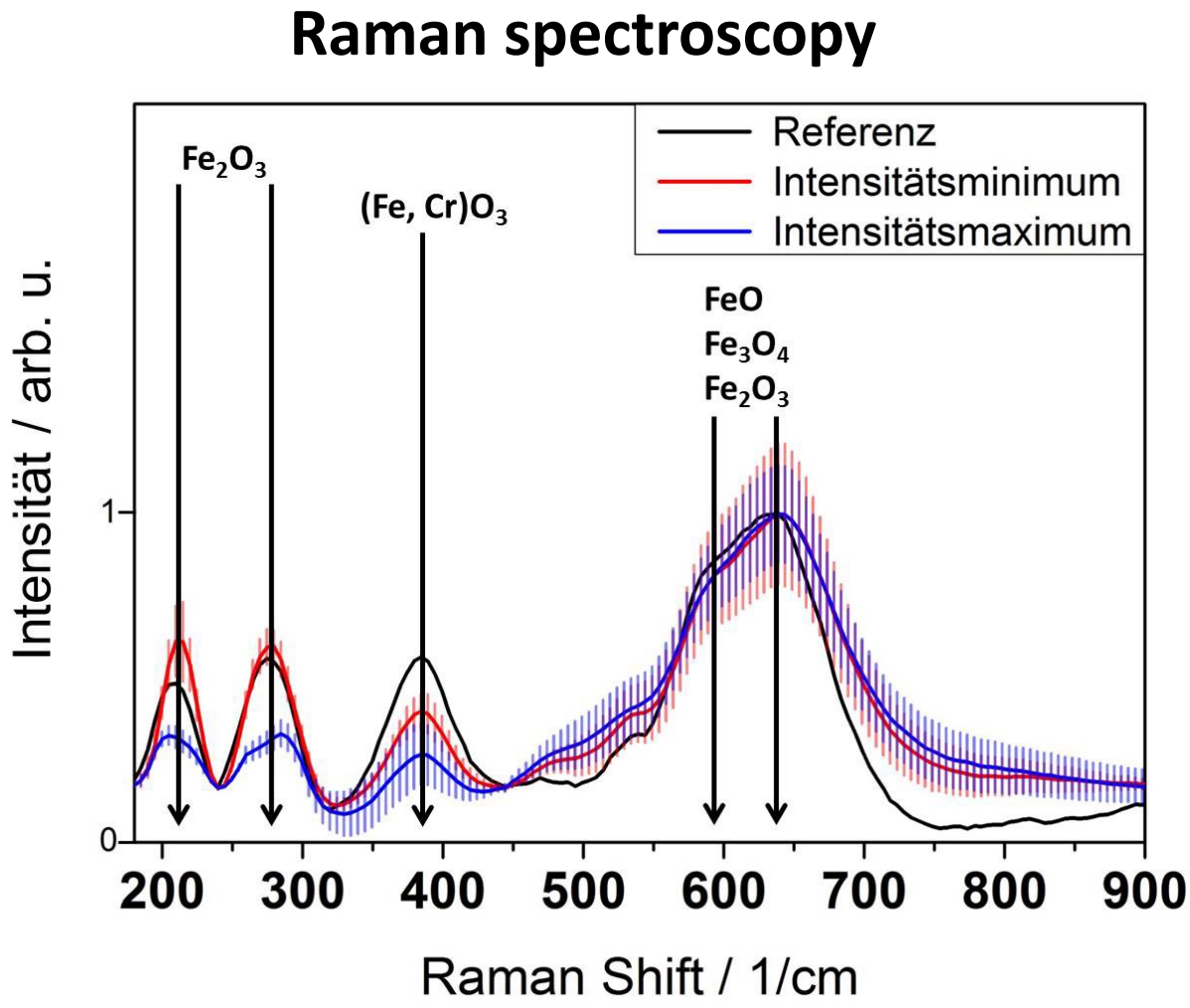


Rosenkranz et al., Wear 2014, 318, 49-61.

Raman spectroscopy



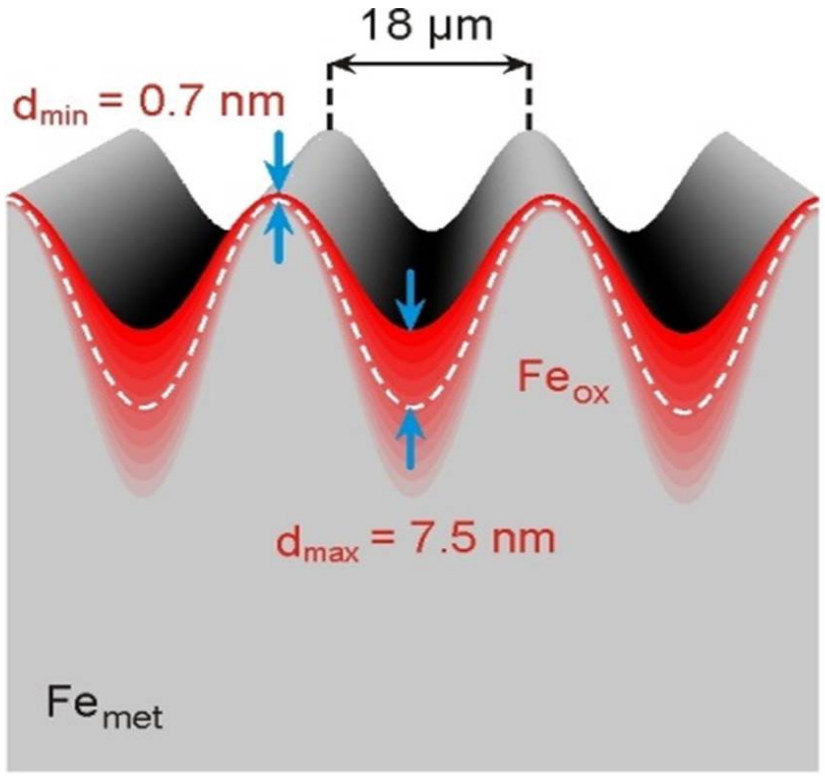


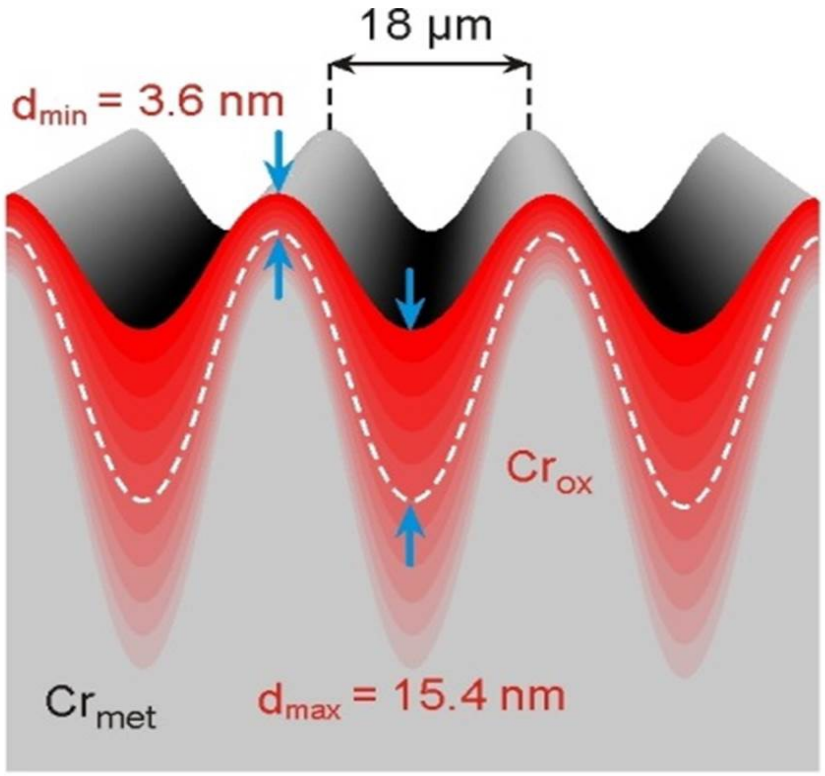


Rosenkranz et al., Advanced Engineering Materials 2015.

X-ray photoelectron spectroscopy

X-ray photoelectron spectroscopy

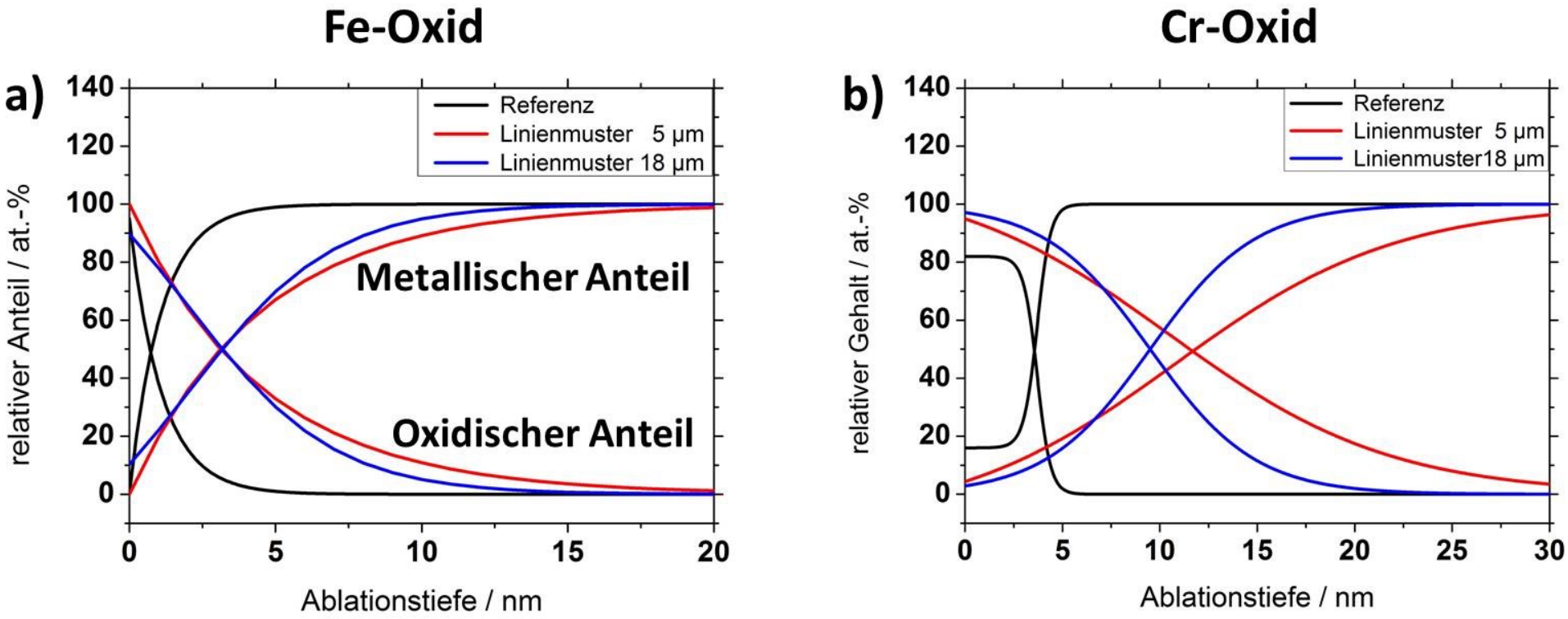




DLIP leads to an increase in the oxide layer Thickness by a factor of 5!

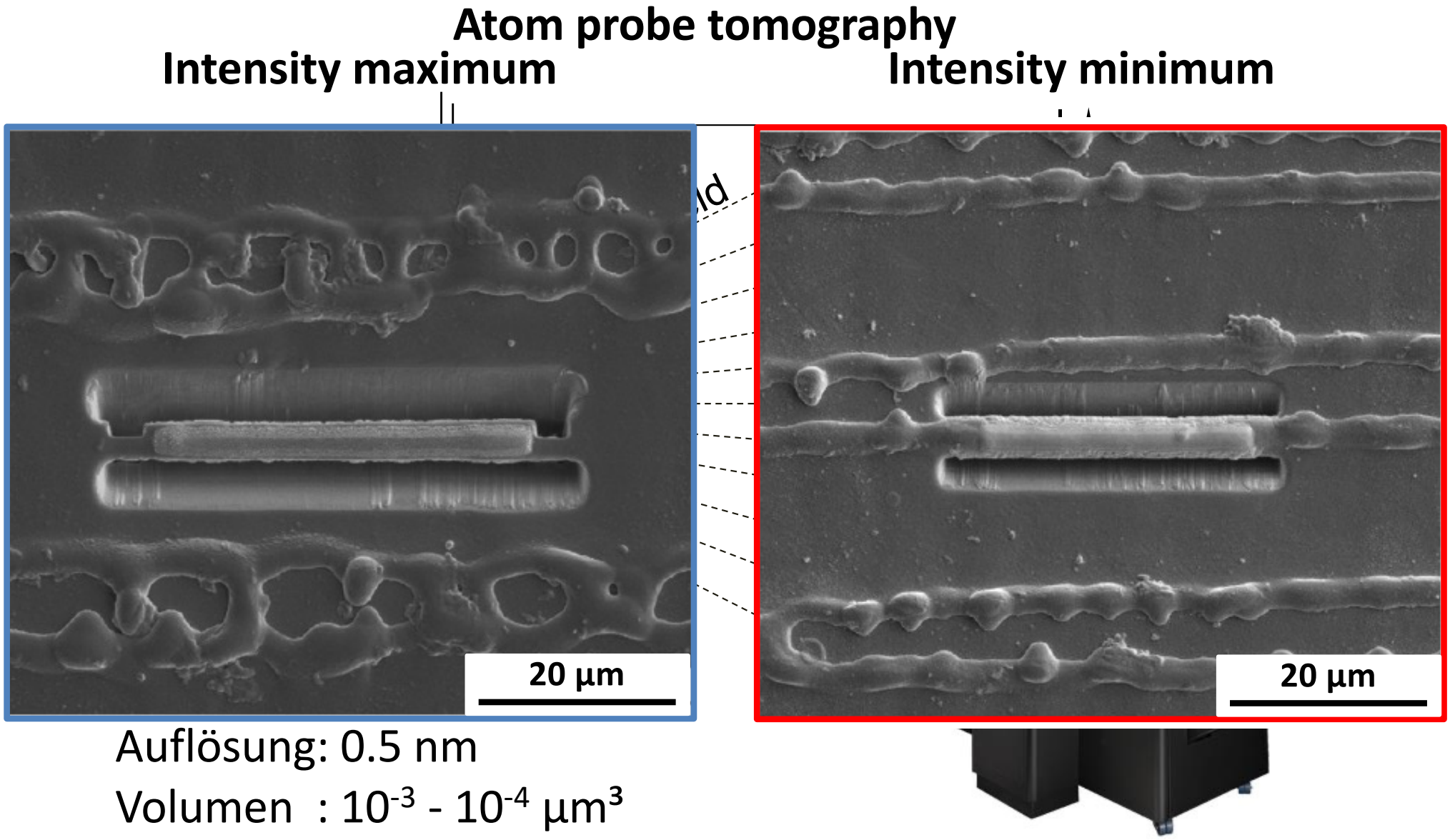
Rosenkranz et al., Advanced Engineering Materials 2015.

X-ray photoelectron spectroscopy



Rosenkranz et al., Advanced Engineering Materials 2015.

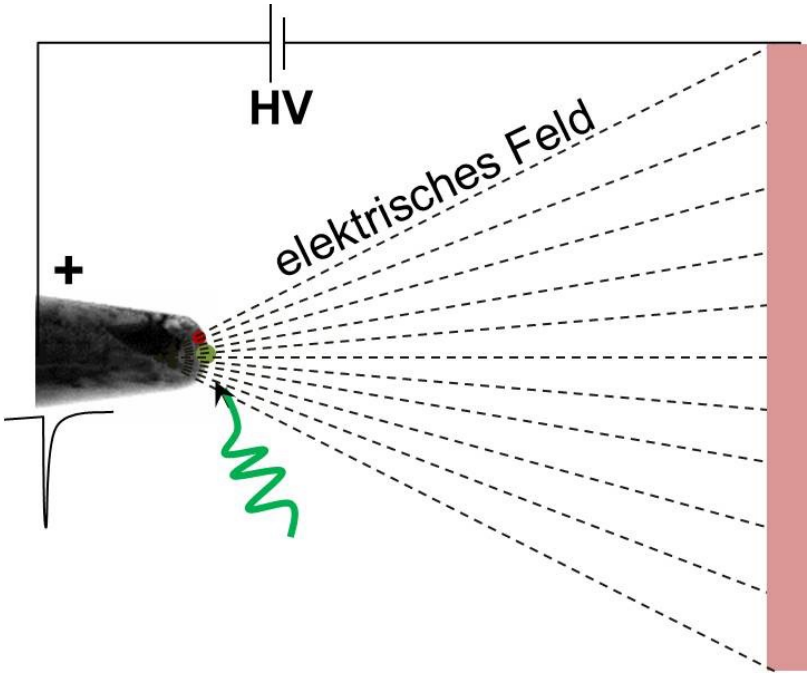
Atom probe tomography



Auflösung: 0.5 nm

Volumen : 10^{-3} - 10^{-4} µm³

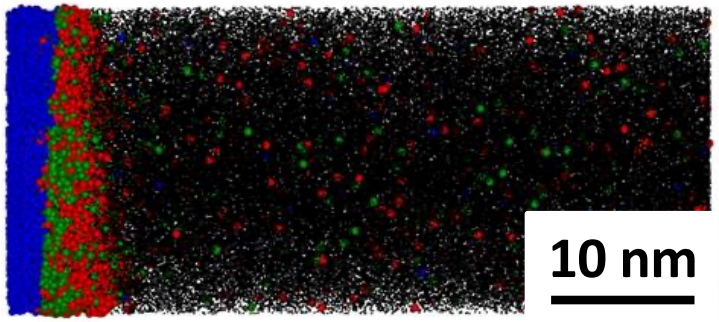
Atom probe tomography



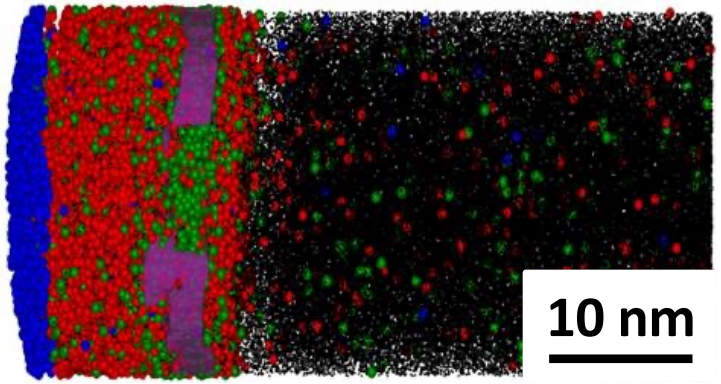
Legende

● Fe ● O
● Cr ● Ti

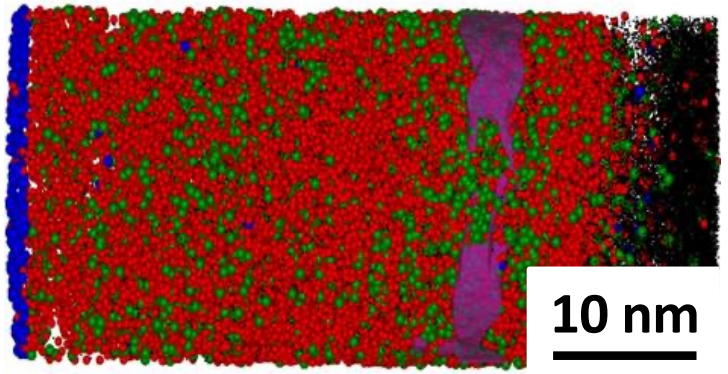
Referenz



I_{min}



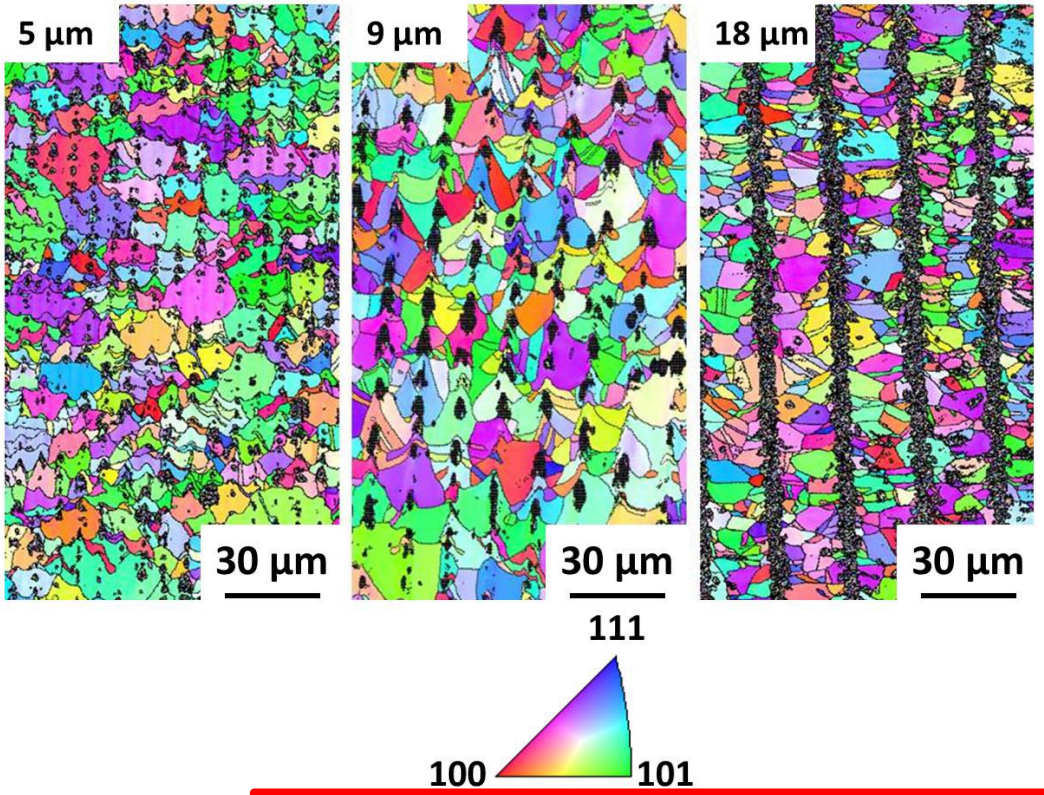
I_{max}



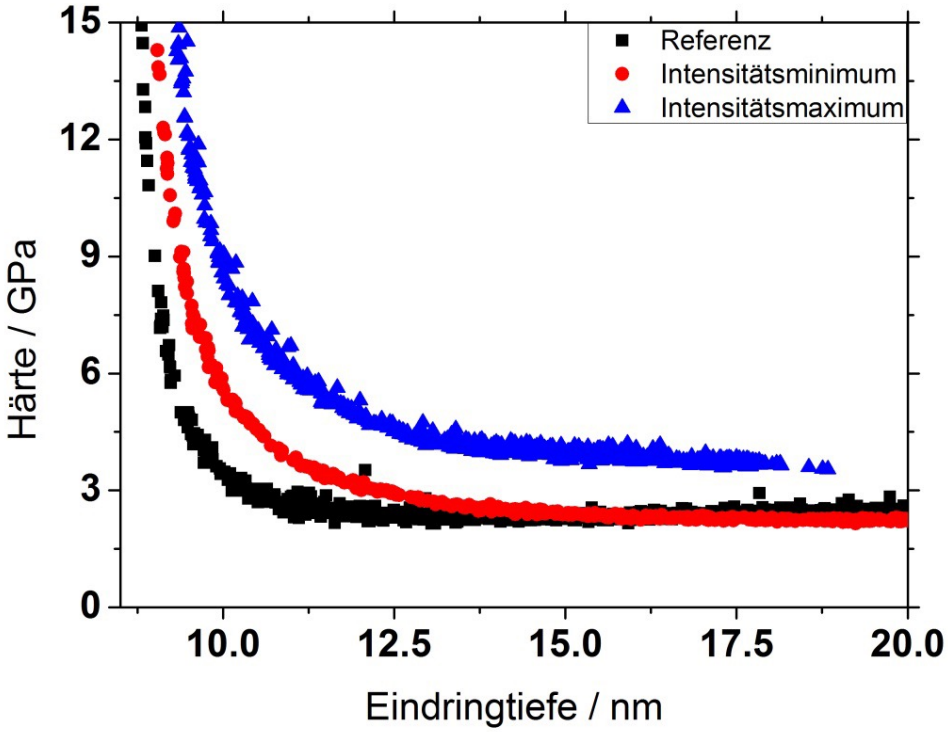
Rosenkranz et al., Advanced Engineering Materials 2015.

Electron backscatter diffraction

Electron backscatter diffraction



Nanoindentation



Probe	Referenz	5 µm	9 µm	18 µm
Korngröße / µm	8,67 (± 4,6)	8 (± 5,76)	6,9 (± 4,84)	5,65 (± 3,8)

Hardness increase observed for laser intensity maximum, but no change in mean grain size and grain orientation could be detected!