# Smart manufacturing solutions for the European Photonics Industry

Michael Thiel, Co-founder of Nanoscribe

Berlin, 29th of August, 2019

# Who is Nanoscribe?

## Facts & Figures

# Nanoscribe at a glance

The **NANOSCRIBE Group** is an international leader in the field of additive 3D microfabrication and maskless lithography. The company operates subsidiaries in the US and in China and is headquartered near Karlsruhe, Germany. Distributors are established in more than 10 countries.

Nanoscribe GmbH is privately owned and is partner company with ZEISS. The Group's products and services set standards in microfabrication since its **foundation in 2007**.


**Products**

- Microfabrication systems
- Resins & consumables
- Processes
- Software
- Technical consulting & services

**Markets**

- Industrial Microfabrication
- Scientific Instruments
- Micro-Optics
- Advanced Optical Packaging
- Wafer Level Optics
- Life Sciences

# Recent Awards & Perception by the Media

**LASER Innovation Award, 2019**
First price among 1,300 exhibitors with 5,000 EUR

**Landespreis für junge Unternehmen, 2018**
First price, endowed with 40,000 EUR

**DPG Technology Transfer Award, 2017/18**
Transfer scientific research to commercial product

**CTO of the year Europe, 2016**
Category SME

**World Technology Award, 2015**
Category *Materials*, Jury: 3 Nobel prize laureates

**Deutscher Gründerpreis, 2015**
Finalist of the highest ranked entrepreneur award


# Scientific research & Prototyping

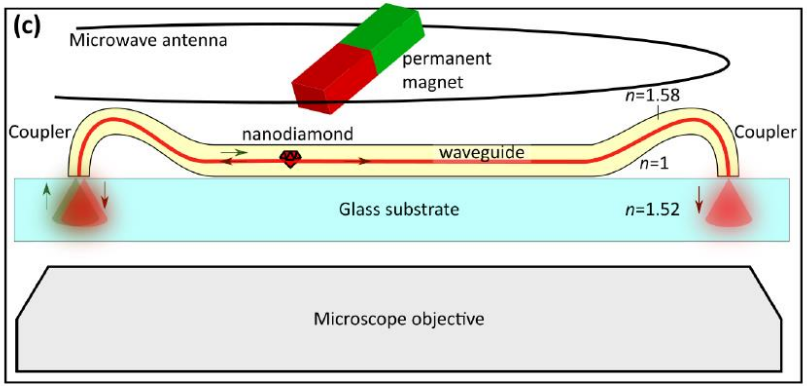
Empowering cutting-edge science and industrial innovations with two-photon 3D printing

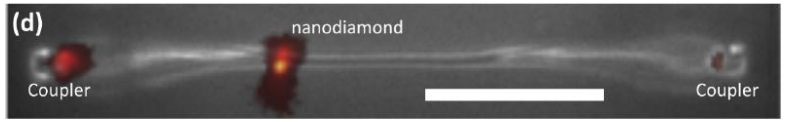

Video on Youtube:
https://www.youtube.com/watch?v=ZpgLGFYoUTc



Actual SEM images

# Success story: Coherent Remote Control over Nano-Emitters Embedded in Polymer Waveguides



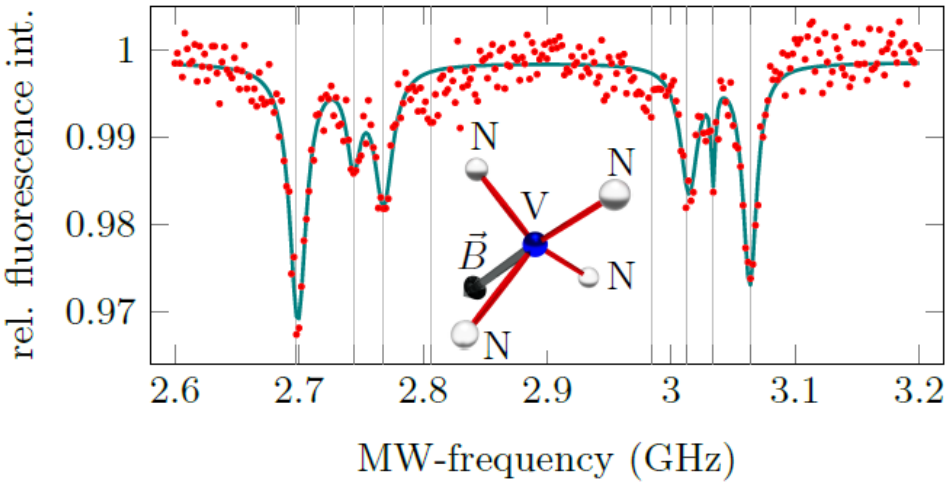

EMCCD image

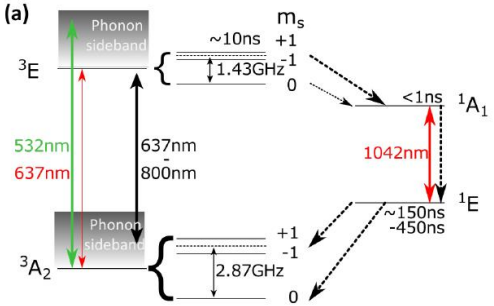

SEM image



Alexander Landowski et al., arXiv:1811.12868v1

# Success story: Coherent Remote Control over Nano-Emitters Embedded in Polymer Waveguides

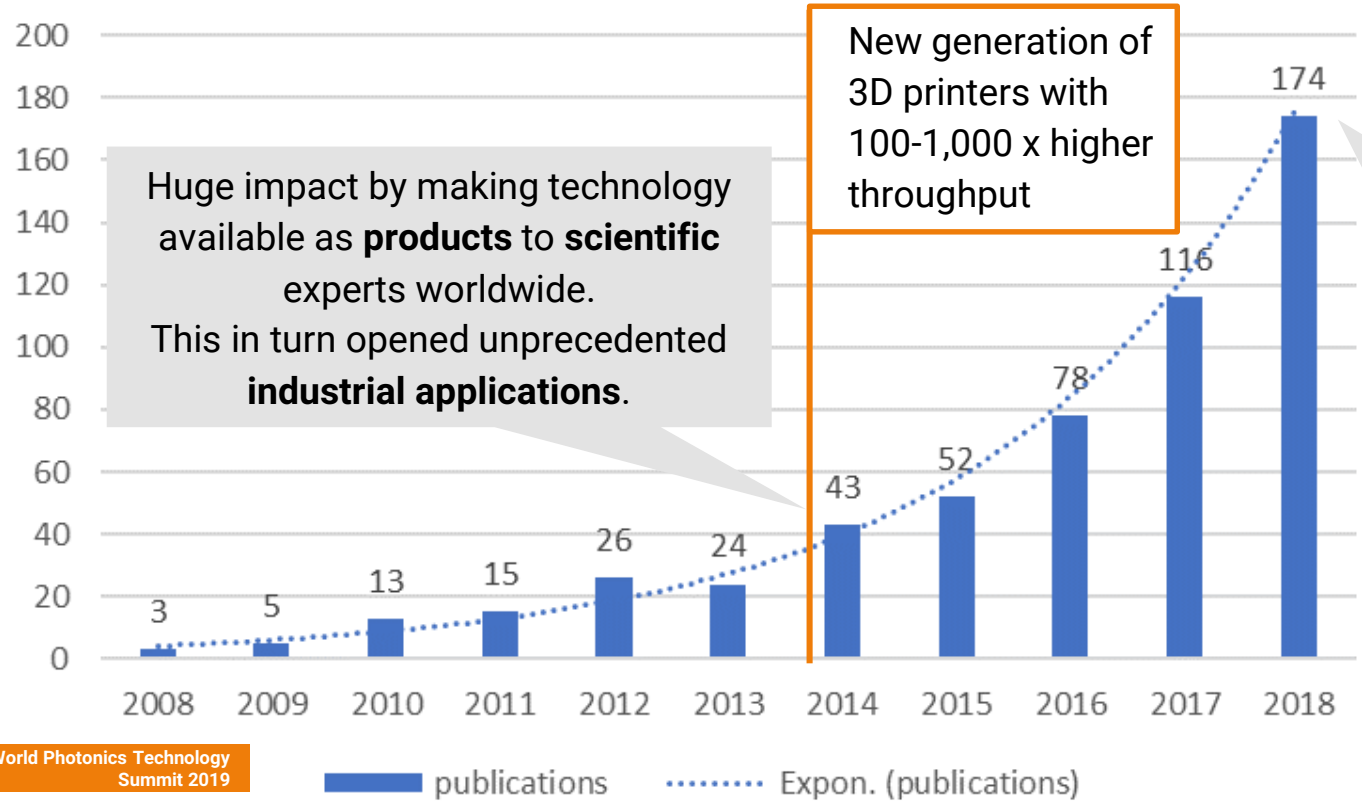





Alexander Landowski et al., arXiv:1811.12868v1

# Enabling Ground-Breaking Research: Yearly publications with Nanoscribe 3D printers




Huge impact by making technology available as **products** to **scientific** experts worldwide.
This in turn opened unprecedented **industrial applications**.

New generation of 3D printers with 100-1,000 x higher throughput

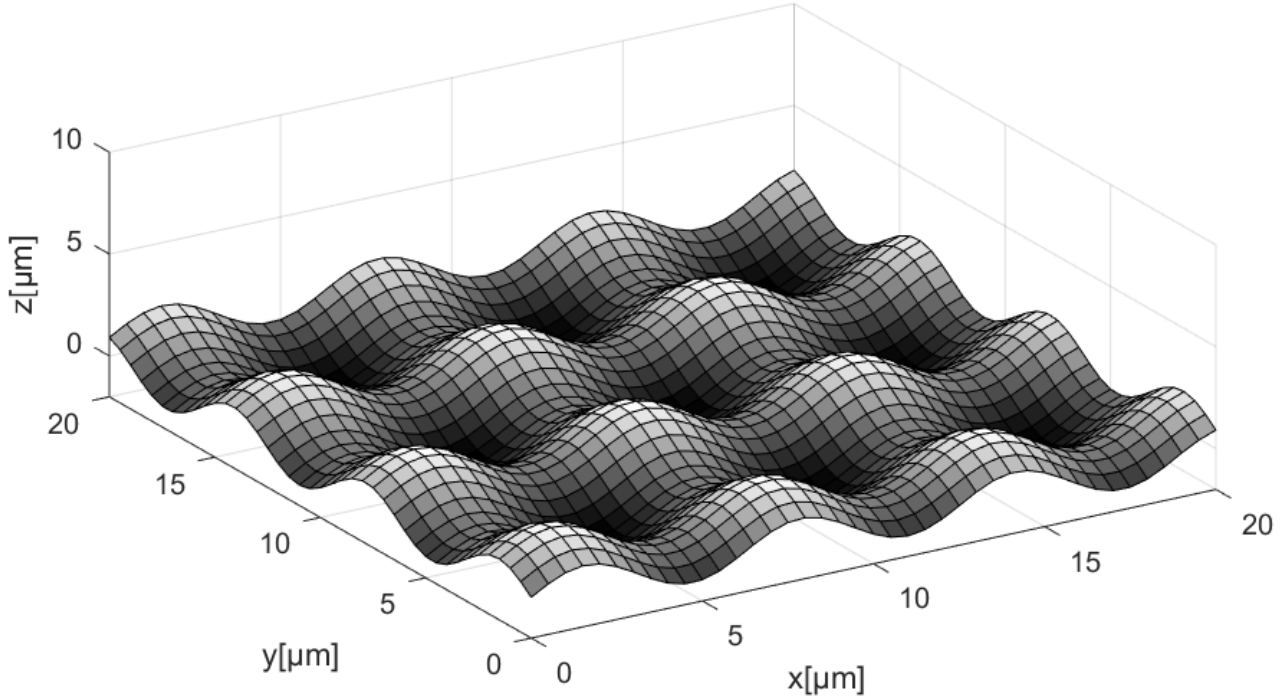
Today
**> 550 journal publications** with Nanoscribe 3D printers


# Wafer-Level Optics

Industrial microfabrication with Two-photon Grayscale Lithography

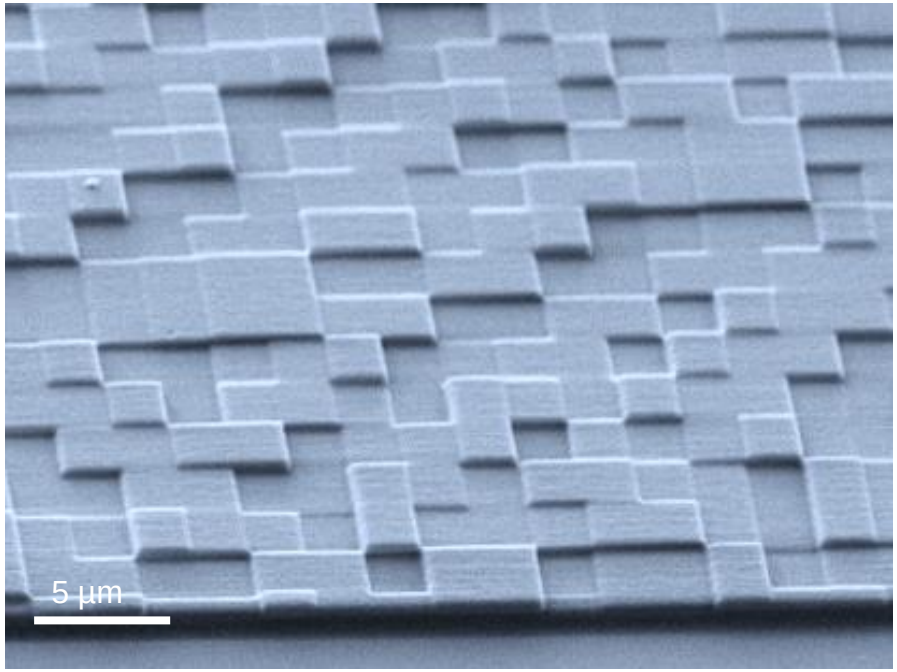
EPIC World Photonics Technology Summit 2019

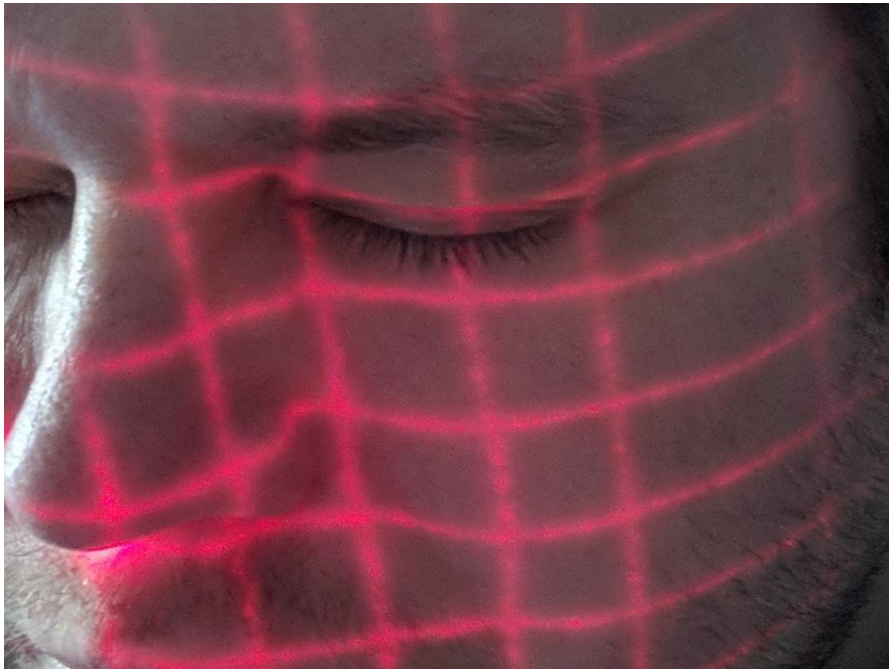
# Grayscale Lithography




Modulated dose pattern is transfered into topography after development

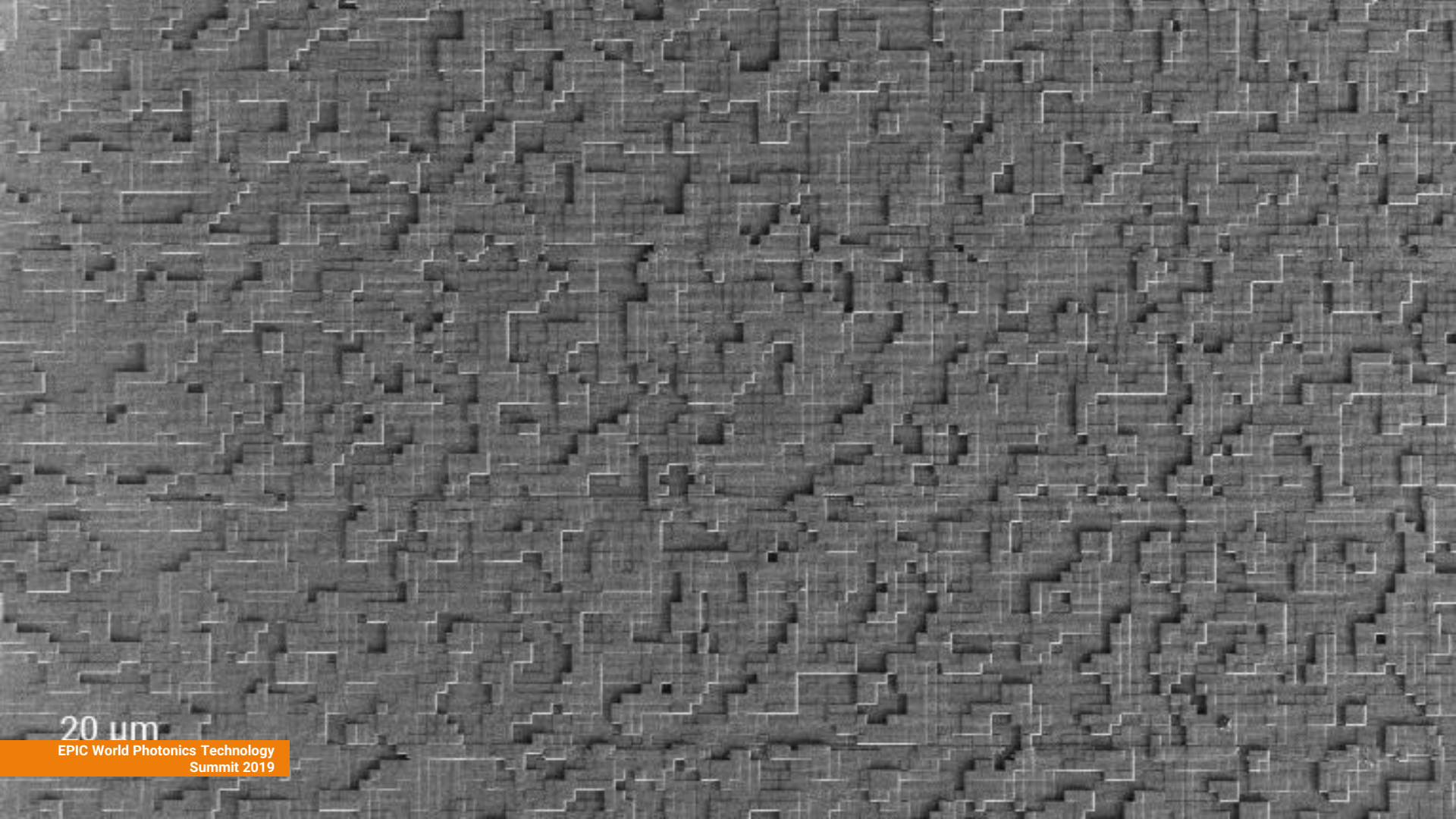
# Diffractive optical elements



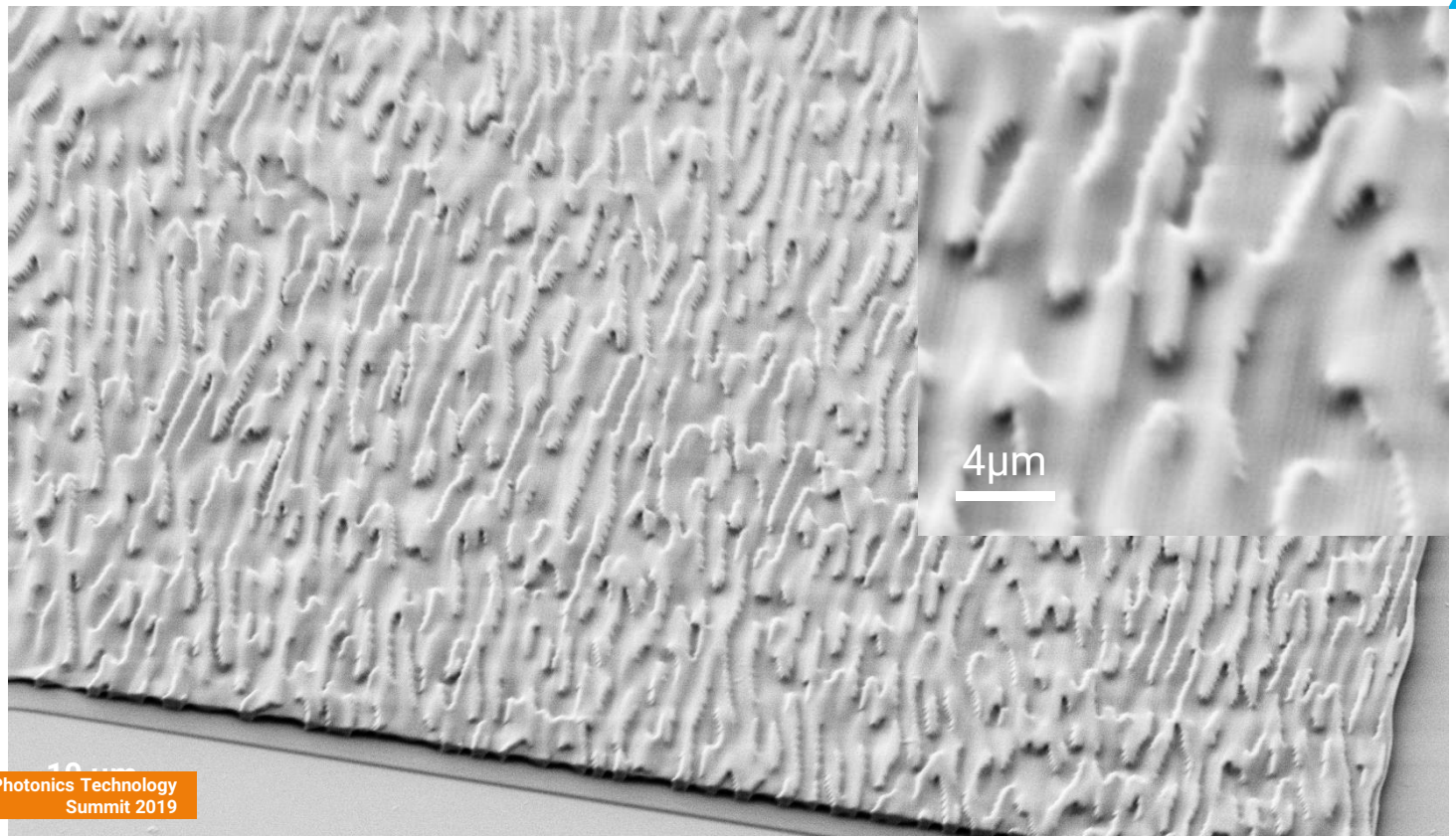





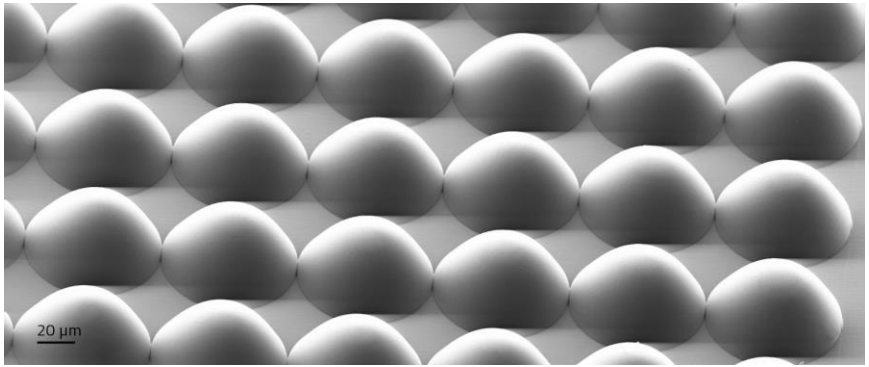
M. Thiel, JS LIM/CLEO-2.3, Cleo Europe (2017)

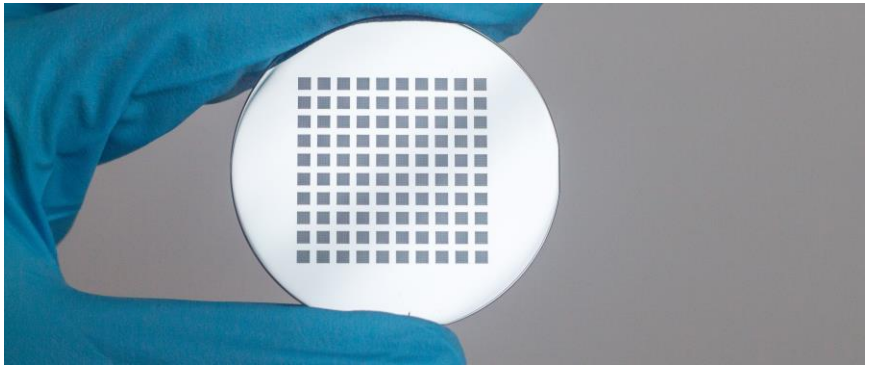

20 µm

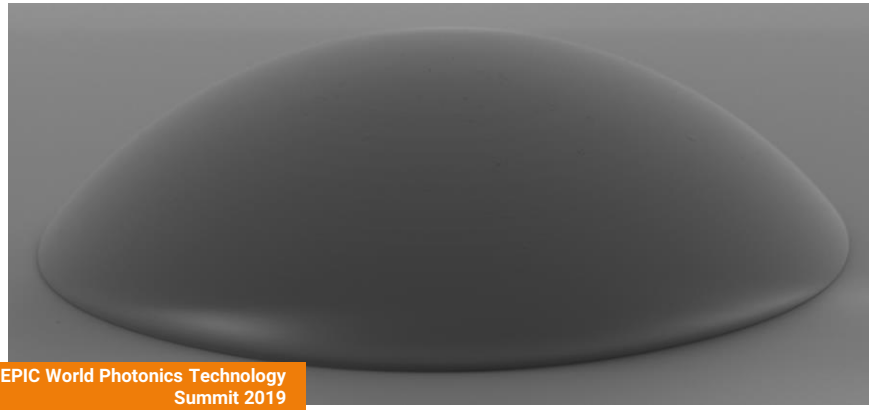
# Quasi-continuous DOE (4096 levels in 1 step)

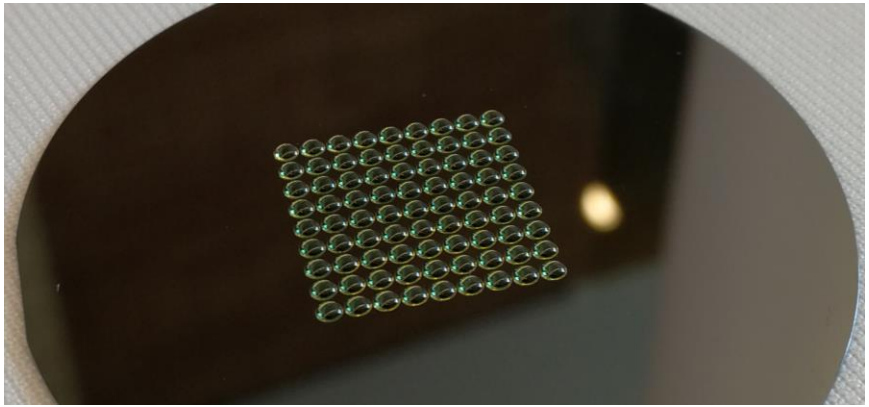


# Microoptics



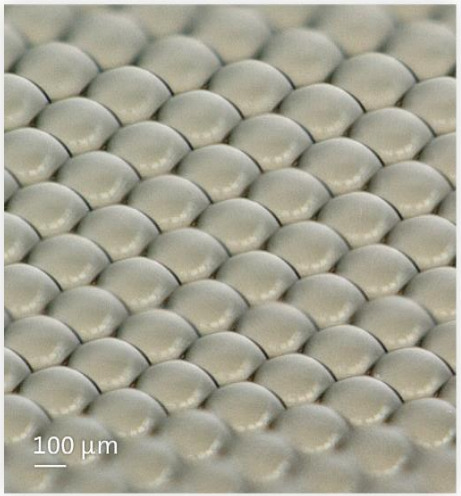




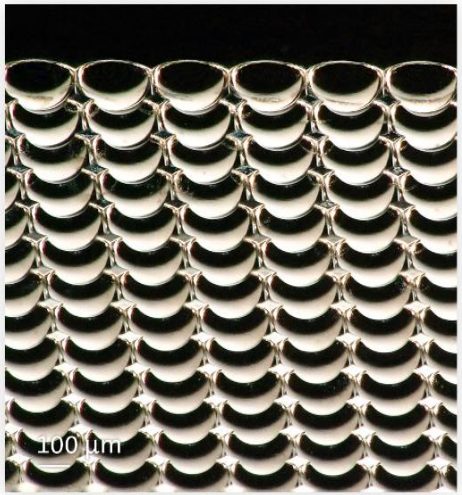
# Success story: Serial Production by Injection Molding

3D Printing → Electroforming → Injection Molding

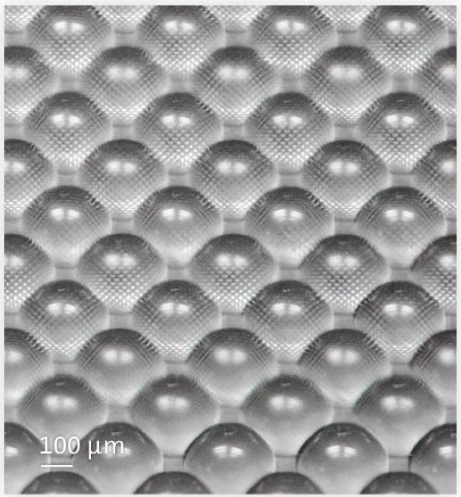
Microlens Array (MLA)




Polymer Master




Nickel Shim

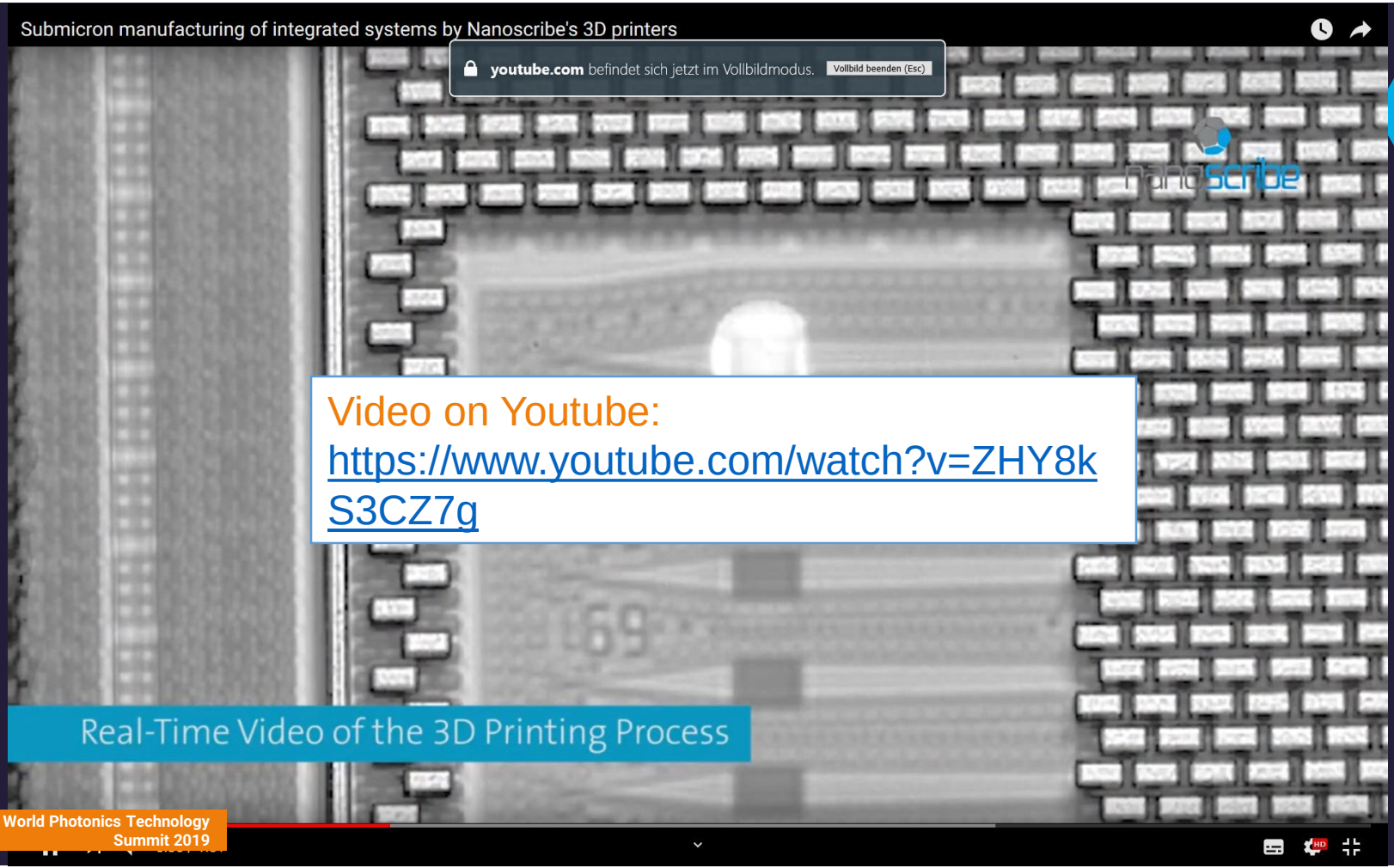



MLA Replica

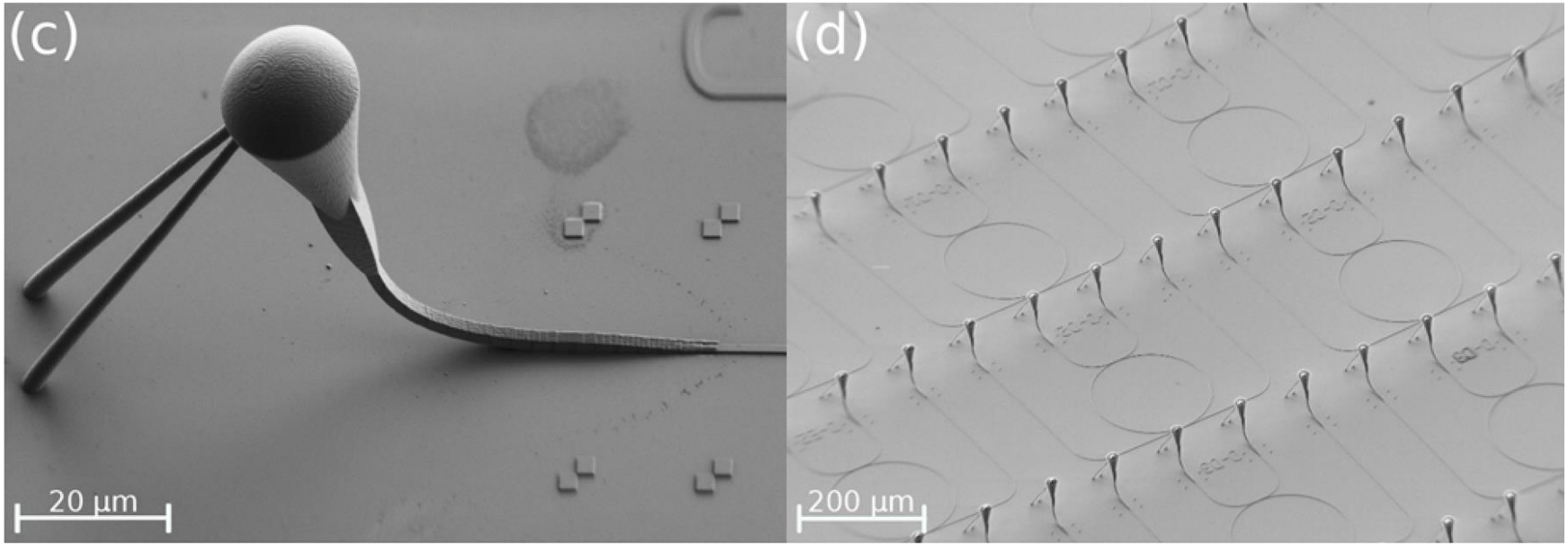
# Advanced Optical Packaging

Connections without active alignment

EPIC World Photonics Technology Summit 2019


Submicron manufacturing of integrated systems by Nanoscribe's 3D printers
youtube.com befindet sich jetzt im Vollbildmodus.
Vollbild beenden (Esc)
nanoscribe
Video on Youtube:
https://www.youtube.com/watch?v=ZHY8kS3CZ7g
Real-Time Video of the 3D Printing Process

# Success story: Low-loss fiber-to-chip couplers with ultrawide optical bandwidth



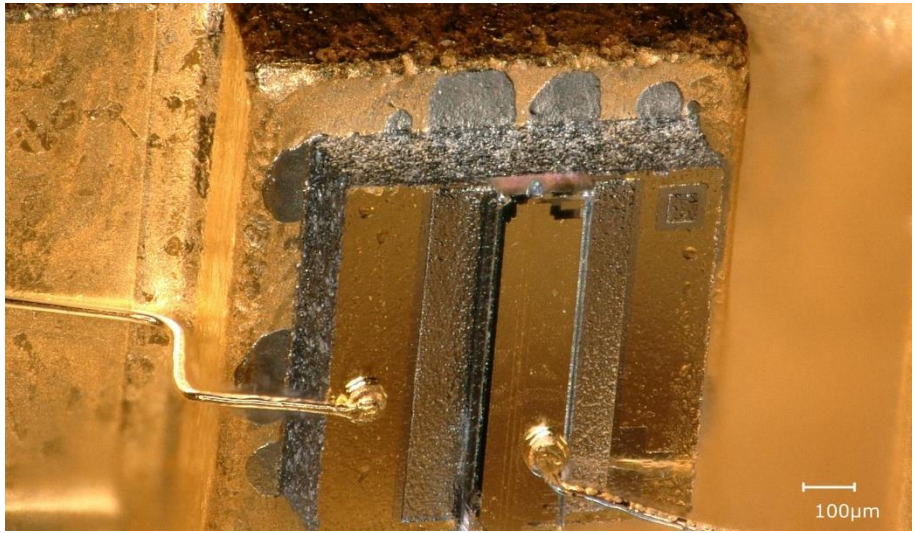



M. Blaicher et al., Pernice group, APL Photon.4, 010801 (2019)

# Miniaturized light-sources for medical and mobility applications

Bundesministerium für Bildung und Forschung

MiLiQuant




**Project Partners:**

- Q.ant GmbH
- Robert Bosch GmbH
- Carl Zeiss AG
- Nanoscribe GmbH
- University of Mainz
- University of Paderborn

- Miniaturized light sources based on diode lasers
- Frequency- and power-stable light sources will allow maintenance-free use outside of laboratory conditions
- Goal is to enable industrial quantum technology

# Conclusions & Outlook

# Our Headquarters – ZEISS Innovation Hub @ Karlsruhe Institute of Technology (KIT)


# Thank you for your attention!

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