Startup Contest Application

International Conference on Electron, Ion, and Photon Beam Technology and Nanofabrication

1. Venture Name.
HETEROMERGE

2. Team Leader and Primary Contact Information.
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3. Additional Team Members.
Dr. Ye YU, Mr. Man Ho WONG, Mr. Siddharth DAS; Mr. Jörg KNORR

4. Describe the business opportunity.
Today very small nanoscale 3D structures with high resolution can already be printed using two-photon laser lithography (2PP) systems. A growing number of applications need 3D structures with different materials and multiple properties (e.g., micro-optics or tissue engineering). However, nanoscale multi-material 3D printing is an unsolved challenge. The state-of-the-art solution is manual changing materials, being very slow, not accurate (interface problems after material exchange) and inconvenient, and thus not applicable for printing at large scale, which limits the further acceptance of two-photon technology at industrial scale.

5. Describe your technological solution.
Based on longstanding research and our patented technology, we offer innovative hardware, which enables fast and convenient multi-material 3D printing on 2PP systems (Figs. 1-4) – substrate independent, on wafer level, and without any size restrictions. With our add-on solution to existing systems, our customers can transform their systems into a new generation of 3D printers to reach multi-material additive fabrication

- with material exchange 10x faster than today,
- at the highest resolution (10 nm placement accuracy),
- without design limitations and
- directly on active devices.

6. Who is your competition and what are your product differentiators?
Currently, there is no direct competition for our multi-material system and potential competitors would have to develop a solution that does not infringe our patent in the target market of 2PP systems. Today, our target group (users of 2PP systems) can decide between printing nanoscale multi-material structures with manual material exchange – with all limitations (see No. 4) or using alternative methods. Those methods or technologies, like polymer replication techniques are not directly suitable for multi-material structures and require unfavorable multiple single fabrication steps and later assembly of sub-components.

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7. Describe the Market Opportunity.

Today, 2PP systems for 3D printing are mainly used in R&D. The high precision is offset by a rather slow printing process, which makes it more profitable to use other technologies for high-volume manufacturing. We believe that highly precise multi-material printing enables a dramatic growth in applications for those printers and therefore for using it. While the free-form additive fabrication of micro-structures was not sufficient to enter high-volume manufacturing, convenient multi-material processing can be the game changer. Our add-on-hardware is the missing link for the industrial user. We follow an overlapping 3-phases-strategy:

1. *Entry – add-on solution to existing systems (Year 1-4; turnover about USD 1 M per year)*: The market size is determined by (already sold and new) 2PP systems. There are about 400 systems existing with CAGR roughly 20%. We expect to sell 25 add-on systems per year for the first 4 years.
2. *Expansion – module for OEM (Starting in year 2; turnover about USD 3 M per year)*: Showing the potential of multi material printing, our add-on-solution becomes interesting for OEMs of 2PP systems. In this stage, we change gradually from an add-on-solution provider for end customers to a supplier, selling a multi-material module for OEM systems. As we expect a lot of new applications due to multi-material printing, we assume a growing market for 2PP systems and thus a growing demand for our multi-material module (almost all 2PP systems will be delivered with multi-material module – like color printers vs. black/white printers today). We expect selling about 100 modules per year.
3. *Transformation – Own system (Starting in year 5; turnover about USD 25 M per year on a saturated level)*: This stage describes the vision of HETEROMERGE to become the champion OEM for multi-material nanoscale printing (2PP or other technology). Using the profit from phase 1 and 2 (and other sources of finance) we will develop this new generation of system.

We will also sell services, printing resin, and consumables needed for our system at each stage.

8. Describe the Team.

Dr. Robert Kirchner has an engineering degree from Technische Universität Dresden and 10+ years of experience in 3D micro-nano-fabrication. He drives the vision, the strategic development, and supports the system design. *Dr. Ye Yu* is an experienced researcher with a wide background in material science, nanofabrication technologies, and nano-optics/plasmonics. She now leads the product and material development team. *Man Ho Wong* holds two degrees in engineering and worked as a mechanical design engineer. He is mainly responsible for the mechanical design of the system. *Mr. Siddharth Das* holds a degree in Physics and Electronics. He is majorly responsible for hardware and software co-integration. *Mr. Jörg Knorr* holds a degree in economics, has long-term business experience in different positions and is experienced in spin-offs as well as in the growth of companies. Jörg oversees finances and mainly drives business development.

The team is driven by the vision of nanoscale multi material printing, has an excellent knowledge of the technology, the entry market, and is ready to gain new experience for future markets. Our interdisciplinary and intercultural setting are ideal for a deep-tech spin-off and dynamic learning.

9. Describe any traction.

We received a pre-seed funding of about USD 1 M (EXIST Transfer of research (about 50 spin-offs per year are financed via this program in Germany).

Figures and Additional Information

Clean multi-material separation

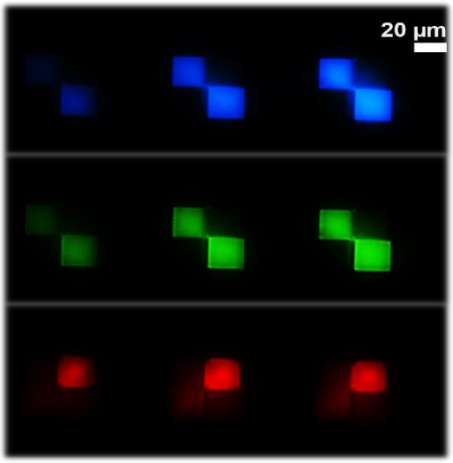

Fig. 1 – Optically active materials: Micro-cubes printed, using a consecutive exchange of three different materials, demonstrating clear material separation.

Print: Nanoscribe Photonic Professional GTII with HETEROMERGE in-situ material exchange.

Hybrid multi-material 2.5D + 3D printing

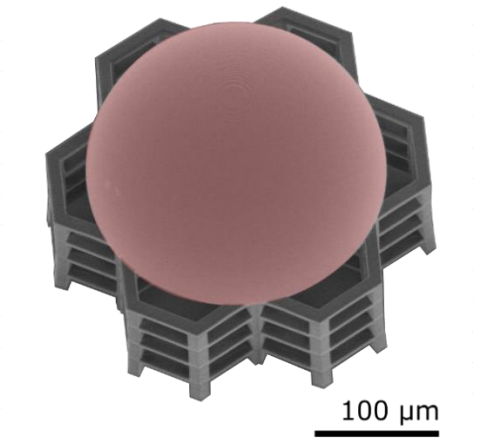

Fig. 2 – Lens on scaffolding: Visualization of micro-lens printed on top of a scaffolding using 3D two-photon laser lithography that can be done with multiple materials.

Print: Nanoscribe Quantum X.

Multi-material full 3D printing

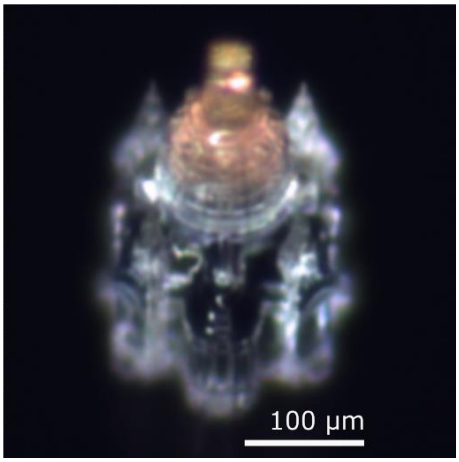

Fig. 3 – Frauenkirche: Miniature model of the Frauenkirche Dresden (Church of our Lady). Darkfield microscope image of model using in-situ material exchange: non-fluorescent PETA replaced by fluorescent PETA.

Print: Nanoscribe Photonic Professional GTII with HETEROMERGE in-situ material exchange.

Large Area printing

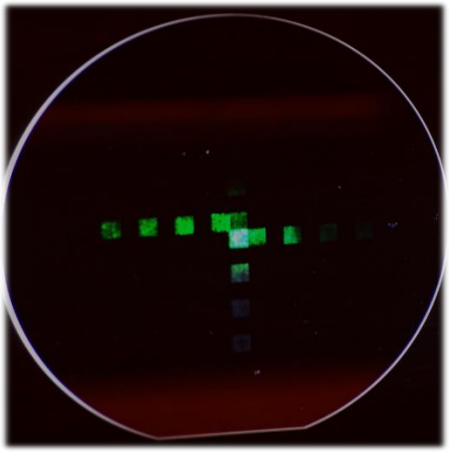

Fig. 4 – Material Resupply: Diffractive gratings demonstrating continuous large-area printing enabled by material resupply providing for minimal surface contamination.

Print: 100 mm fused silica wafer printed on Nanoscribe Photonic Professional GTII with HETEROMERGE in-situ material resupply.

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HETEROMERGE
your materials to the focus