Innovative Diamond Micro-Lenses enabled by 3D Micro Printing

Responsible:	Prof. Niels Quack	ELG 236	niels.quack@epfl.ch
Scientific Assistant Contact:	Adrien Toros	ELG 232	adrien.toros@epfl.ch

Project Type:	Semester Project	Section:	Microengineering

Official Start Date:	18 September 2018
Submission of Final Report:	11 January 2019
Presentation at Group Meeting:	TBD, before 24 January 2019

Project Description:

Single crystal diamond is an outstanding material for the fabrication of micro-optical components, thanks to its excellent optical, thermal and chemical properties. In this project, the goal is to develop a new fabrication method based on 3D Micro Printing (also known as 3D laser lithography) to obtain high aspect ratio, arbitrarily shaped diamond micro-lenses, with potential applications in high-power, laser or spectroscopy optics. The micro-lenses will be designed, and a prototype will be fabricated in the Clean Room laboratories CMi at EPFL. The fabricated micro-lenses will be mechanically and optically characterized.

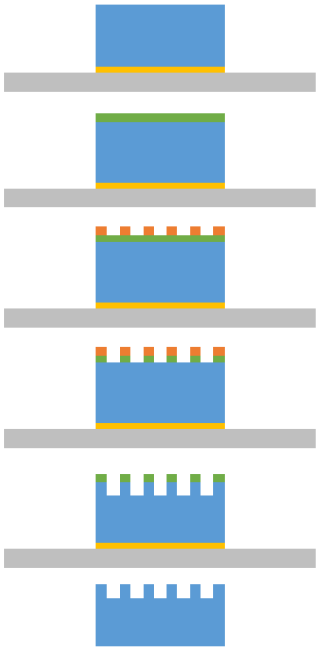

Fig. 1: Schematic representation of a possible fabrication process

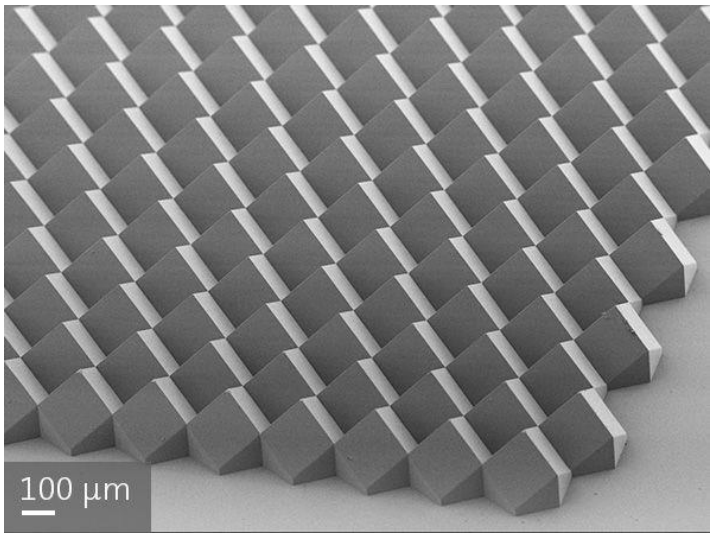

Fig. 2: Polymeric structures obtained by 3D laser lithography (nanoscribe.de/files/1314/7308/3021/AppNote_MicroOptics_V02_2016_web.pdf)

Proposed Project Timeline:

Preliminary Preparation Phase during Summer 2018

- Study of research literature on diamond micro-lenses (provided + own search)
- Get familiar with micro-lenses concept and the fabrication methods (in particular thin film deposition, 3D Micro Printing method and etching processes)
- Propose a detailed process flow for the diamond micro-lenses using the CMi template (including the tools to be used for the individual process steps), see also Fig. 1.
- Submit the process flow to CMi for validation.
- Get familiar with layout (e.g. FreeCAD or CATIA) and 3D Micro Printing software (Describe, c.f. https://cmi.epfl.ch/photo/files/Nanoscribe/Describe.manual.pdf)
- (if time permits: start already with the design)

Clean Room Training

- Clean room basic safety training is required and will be performed before the semester beginning.
- Clean room activity will be supervised and supported by Adrien Toros.

Fabrication, Measurement and Reporting Sept 2018 – Jan 2019

- **18 September Start Date**
- Establish concept and design(s) for the micro-lenses
- Propose strategy and setup for the micro-lenses optical characterization
- Finalize Process Flow
- Perform Processing in Clean Room (CMI)
    - Possible Process Elements (to be confirmed):
        - Diamond cleaning (Piranha and/or acetone/IPA and/or O_2 Plasma) and bonding to handling chip
        - Hard mask deposition (sputtering/evaporation/ALD)
        - 3D Micro printing of micro-lenses on diamond surface
        - Transfer of micro-lenses pattern to the hard mask (Dry etching)
        - Diamond etching (Dry etching)
        - Hard mask removal (Dry/Wet etching)
    - Measurements, Quantitative Results (SEM, AFM, WLI), size, curvature, roughness, etc.
- Optical Characterization of the successfully fabricated micro-lenses (Focal length, Optical performance)

- Writing of Report, Preparation of final presentation
- **11 January 2019 – Date of Submission of Final Report**
- **Before 24 January 2019 – Presentation of the Results at the Quack Group Meeting (exact date to be defined)**

The dates are as from the academic calendar on 23 August 2018, which should correspond to the official dates. However, the official dates are communicated by the Service Académique (SAC). It is the student's responsibility to respect the deadlines and the administrative formalities of the reporting to the Service Académique (notably on isa.epfl.ch).