FIBER TIP MICRO-OPTICS

Workshop of Photonics

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INTRODUCTION

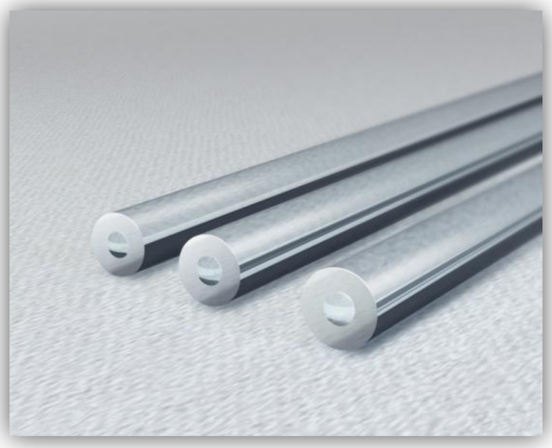
Workshop of Photonics*, a laser technology research and development brand of Altechna Co. Ltd, develops techniques for optical fiber processing using femtosecond laser instruments.

Complex structures from sol-gel polymer materials are formed on the optical fiber tip for beam formation, with possible applications in laser manufacturing, optical sensors, laser medicine, minimally invasive surgery, etc. This fiber optics allows a high efficiency coupling and a low return loss without any additional non-fibered type component. Fiber optic can be transformed to improve beam shaping, mode matching and coupling efficiency with the waveguide device, laser diode chip or photo diode chip. As options, AR coating, metalizing and fiber assemblies are available in-house.

Progressive discount for large quantities order.

We can offer you:

1. We have the ability to design and manufacture fiber optic products to meet your application needs (feasibility studies).
2. Small scale production.
3. FemtoFAB workstation for polymerization applications.



TECHNOLOGY

Femtosecond Laser Multiphoton Polymerization (FLMP) technique is used for microstructuring of photopolymers in 3D over a large area in order to produce microoptical elements and integrated components with resolution from 100 nm to 20 μm. Elements are made from sol-gel based organic-inorganic material which is a good choice for fabrication of high quality microoptical elements. They possess good structuring qualities and small achievable feature resolution, are transparent in the visible and near-infrared range, and have refractive indices that can be tuned to match the required value (i.e. identical as of an optical fiber – 1.48) in the range of 1.47-1.56. Additionally, they can be doped with quantum dots, nonlinear chromophores or organic dyes, thus further increasing their functionality to make it suitable for the fabrication of micro-optical and complex integrated microstructures on a tip of an optical fiber.

FLEXIBILITY

The FLMP technology enables fast and convenient fabrication of:

- 2D and 3D photonic elements (i.e. photonic crystal for spatial or spectral light filtering, ect. Fig. 2 a) and c).
- Integrated microoptical component, i.e. microlens on a fiber top Fig. 2 b having any desired curvature radius or any complex shape of the surface.
- Bi-functional refractive-diffractive optics, i.e. micro-lens with 2D grating on it, spiral phase plates.

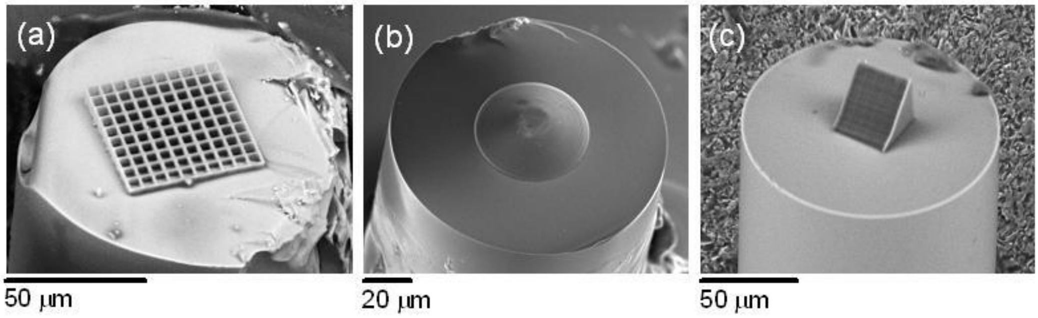


Fig.2 Microoptics on fiber-top

Antireflection Coating Services

- V-coatings
- Multiwavelength AR coatings
- Broadband AR coatings
- Single layer AR coatings

High-Reflection Coating Services

- Single wavelength HR coatings
- Multiwavelength HR coatings
- Broadband HR coatings
- Metallic HR coatings

APPLICATIONS

Fiber-top micro-optics can increase their coupling or splicing efficiencies. Moreover it can be used for imaging inside liquid, since the phase delay of light introduced by the 3D polymeric structure alters the phase of the passing light. Refractive microlenses are widely used in optical communications, digital displays, optical data storage, beam formation and bio-imaging as well as biomedical applications. The diffractive optical components offer complimentary beam shaping versatility.

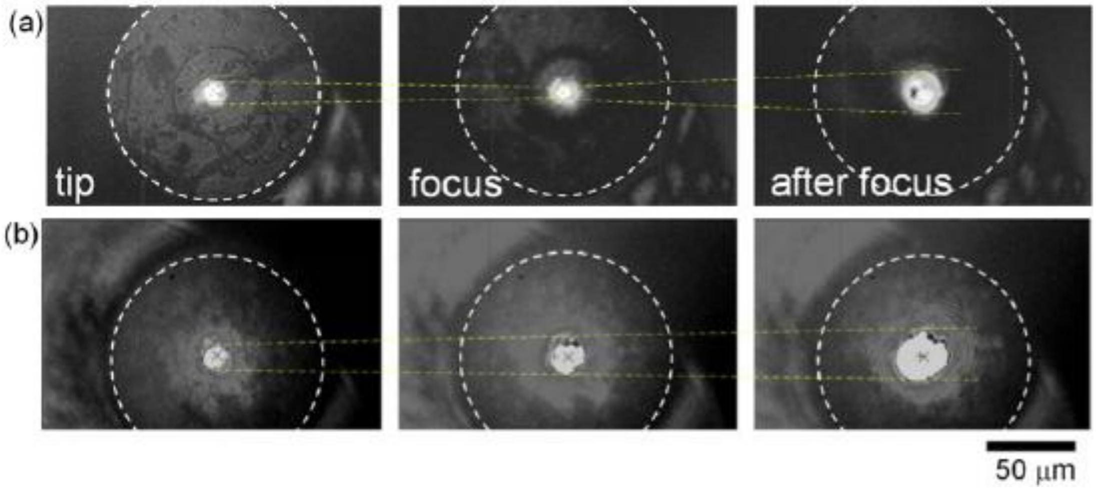


Fig. 3: Focusing of light emitted from the fiber with the tip-lens (a) and without (b). The dashed-circle marks the circumference of the fiber tip; lines are eye guides for the focusing and diffraction. The focus of imaging plane is at the fiber tip z = 0 µm (left), at the focus z = 33 µm, and z = 100 µm from the tip of fiber (right side images).

Microoptical components can be used for optical signal introducing/detection, transferring, filtering and processing applications, yet significantly miniaturizing it. Additionally, it can widen the assortment of elements used for microscopy (like solid immersion lenses) and sensing (grating based sensors), spatial or spectral filtering of light (diffraction/refraction gratings), beam collimating/quality correction. Benefits in laser technology could target correction of LED diode lasers beam divergence (cylindrical lenses), collimating the beam going out of the optical fibers.

PERFORMANCE

Microlenses made of sol-gel synthesized materials are optically transparent over the 400–1600 nm wavelength range. These materials demonstrate low optical losses in the near infrared range, with losses less than 0.06 dB/cm at 830 nm, and less than 0.6 dB/cm at 1550 nm.

Microlenses formed by FLMP technique can hold energy density up to 0.2 J/cm2 (or peak intensities of up to TW/cm2), which makes it suitable for a wide range of applications, including telecommunications, dermatology, oncology. Average deviations from the spherical shape were less than 0.5 μm, which is <2.5% of the absolute value (Fig. 4)

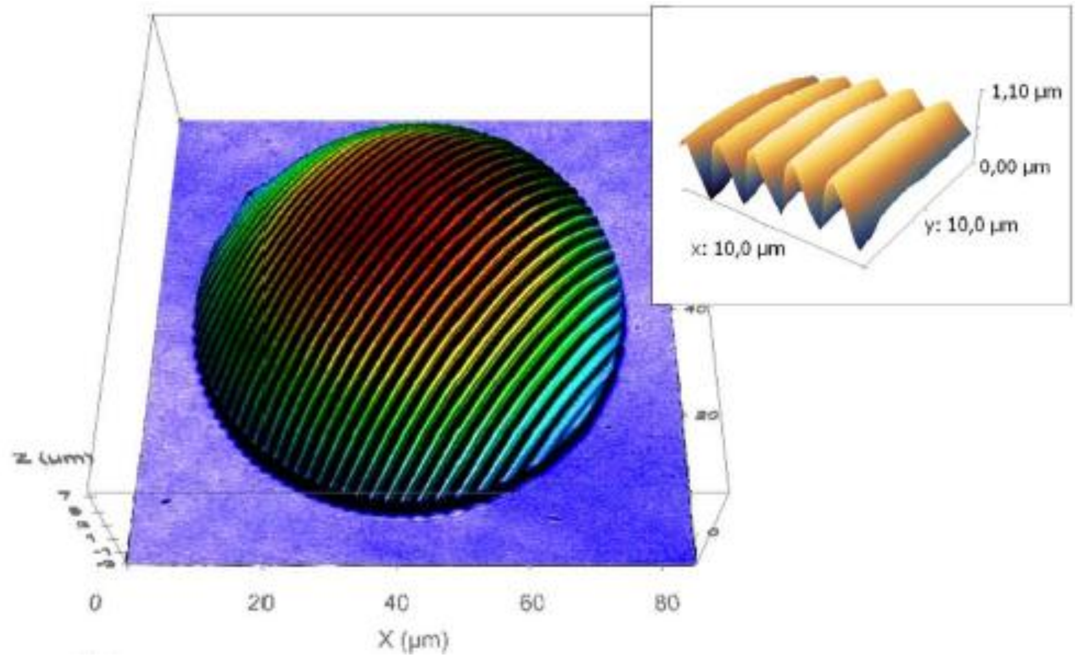


Fig. 4: Hybrid micro-lens with a phase grating, allowing different light flow control variants to be achieved. The grating gives diffraction which can be used as a light dispersing element or as a spectral filter. The grating itself can have not only geometry of parallel lines, but also of perpendicular lines or concentric rings, for ex. lenses with Fresnel zones. The curvature radius of the lens is R = 67 µm, grating period d = 2,4 µm.

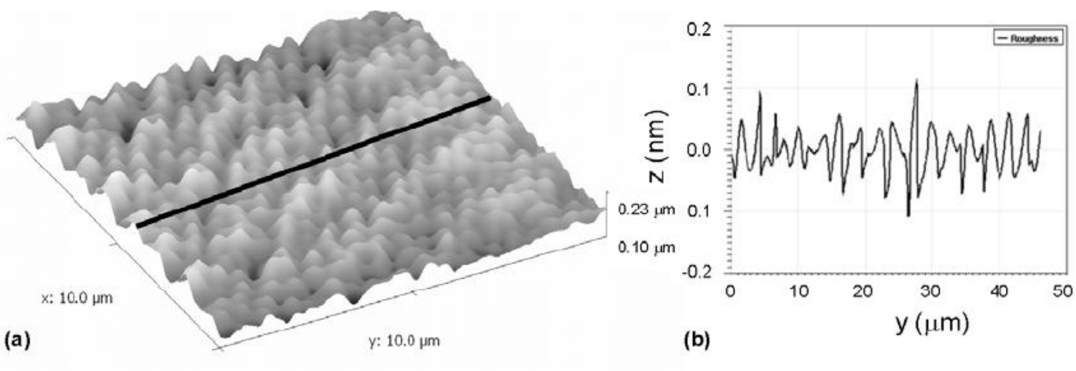


Fig. 5: Surface roughness of a fs-laser polymerized SZ2080 lenses is below ~30 nm. (a) shows typical AFM measured profile and (b) line-marked cross section.

ACKNOWLEDGEMENTS

Workshop of Photonics, as laser technology research and development brand of Altechna Co. Ltd, develops femtosecond laser instruments for multiphoton polymerization technology in collaboration with an associate partner laboratory – Laser Nanophotonics group at Vilnius University Laser Research Center (VU LRC).

‘Workshop of Photonics’ is a registered trademark of Altechna Co. Ltd.

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