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Introduction

Welcome to the third edition of our newsletter in 2006. We hope you have enjoyed your summer holidays and had at least a short break from our dynamic and rapidly growing industry. As always, we would appreciate your feedback so that we can better serve you.

In this newsletter we are highlighting:

- [Liekki introduces polarization maintaining fiber optimized for high-energy amplification](#)
- [Liekki offers cost effective, custom preform manufacturing services](#)
- [Liekki introduces non-circular optical fibers for high power delivery](#)
- [Tsinghua University reports record results with Liekki fiber](#)
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Sincerely,

Bill Willson
 Vice President, Marketing and Sales
 Phone: +1 301 706 0315
 Email: william.willson@liekki.com

Liekki introduces polarization maintaining fiber optimized for high-energy amplification

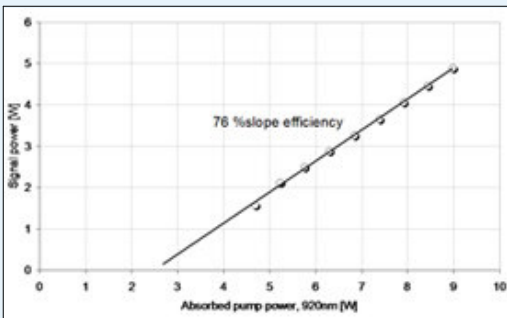


Fig. 1: Cladding absorption of Liekki's Yb1200-20/125DC-PM fiber



Liekki expands its broad, ytterbium-doped fiber product family with a highly doped, large mode area fiber with very high cladding absorption (Yb1200-20/125DC-PM). Typical applications of this fiber are materials processing (cutting, marking, drilling), laser ranging, remote chemical detection, and nonlinear frequency conversion for access to wavelengths from the infrared to the ultraviolet. These applications require pulsed amplifiers with mJ output energies, diffraction-limited beam quality and single polarizations, specifications that have previously been unattainable with fiber-based laser systems. Development of a fiber with a large mode area and short active fiber length provided the breakthrough required to minimize nonlinear effects, the key limitation on the achievable output energy from conventional fiber amplifiers. "Overcoming this limitation will substantially increase the range of applications that can be addressed by fiber lasers", says Mr. Mikko Söderlund, Product Manager of Liekki's fiber products.

The Yb1200-20/125DC-PM fiber features a unique combination of a highly doped, 20 μm diameter core and a large core-to-cladding ratio. These features result in a nominal cladding pump absorption of 7.1dB/m at 920nm rising to as much as 30dB/m for absorption near the peak at around 976nm, enabling use of very short active fiber lengths (less than a meter for 976nm pumping). Applications using this fiber benefit from high extractable energy and excellent beam quality. The use of standard

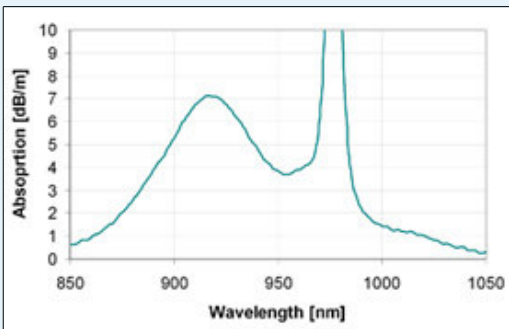
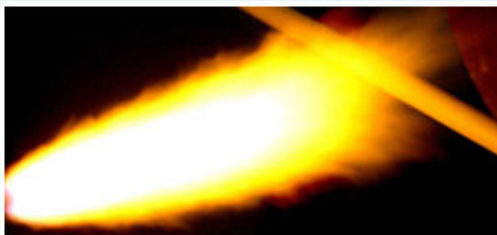


Fig. 2: Typical power conversion efficiency of Liekki's Yb1200-20/125DC-PM fiber

125 μm cladding diameter is another advantage, broadening the fiber's usability, for example, with standard telecom fiber stripping, splicing, and connectorization equipment.

Liekki supplies a passive fiber matched to the active ytterbium fiber, so that excellent beam quality is maintained throughout the monolithic fiber laser or amplifier assembly. Combiners, such as 6+1/1 based on tapered fiber bundle technology, and endcaps are also available through Liekki.

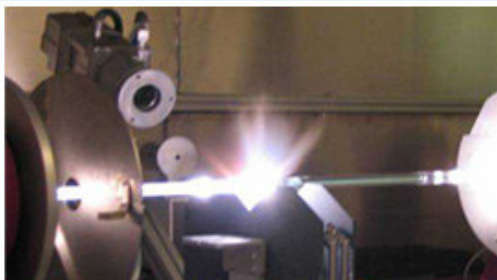
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Pic. 1: DND process - Close up of a preform in the flame

Liekki offers cost effective, custom preform manufacturing services

Liekki expands its broad product line of highly doped fibers, optical engines (OEs) and simulation software with the offering of custom preform manufacturing services. Liekki's Direct Nanoparticle Deposition (DND) process provides single step deposition of extremely highly doped core preforms. DND's nanoparticles also mitigate the onset of clustering and related effects such as photodarkening in ytterbium fibers. Conventional processes require many complicated, time consuming steps in particular for large mode area and large core/clad ratio preforms.

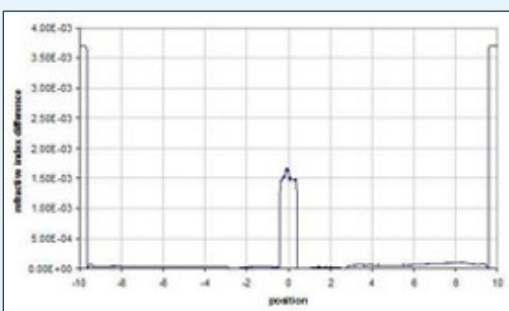


Pic. 2: Glasswork process - Production of complex preforms

In addition to conventional round preforms, Liekki's flexible glassworks technology allows for manufacturing of other non-circular shapes, such as rectangular preforms. "We have recently upgraded our manufacturing facility which has resulted in our preform manufacturing process offering significant performance advantages and lower costs when comparing to conventional processes. We offered our services on a limited basis and had great success. We felt that it was time to offer our preform services more broadly. We continue to offer the highest performance fibers in the industry. Preform supply allows us to leverage additional volume in our facility", says Mr. William Willson, Liekki's Vice President Marketing and Sales.

Each preform is delivered fully characterized with refractive index profile and absorption data.

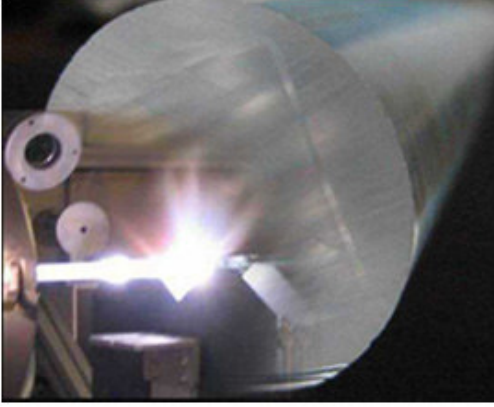
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Pic. 3: Typical RIP of a ytterbium preform

Liekki introduces non-circular optical fibers for high power delivery

Liekki expands its broad, optical fiber line with the availability of square and rectangular core optical fibers. Different combinations, for example rectangular core-round cladding or rectangular core-rectangular cladding are available. The fibers offered today are passive but they will be available as active fibers with ytterbium or erbium doping in the future. "We have been approached by several clients looking for a



Pic. 1: Example of flexible preform manufacturing

different geometric solution for high power delivery. Conventional fiber processes are limited by their deposition and glass works to circular optical fibers. Liekki's Direct Nanoparticle Deposition (DND) technology and a unique glass works process overcome these conventional barriers to provide non-circular shapes", says Mr. Mikko Söderlund, Product Manager of Liekki's fiber products.

"Square or rectangular geometries can be beneficial for improved matching to optical sources, improved beam control and propagation and for routing of fibers in unique footprints. It appears that the applications for these fibers are quite broad, ranging from illumination and signs to ordinance detonation", continues Mr. Söderlund.

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Tsinghua University reports record results with Liekki fiber

Changgeng Ye and others from Tsinghua University reported an average power of 53.1 W, at 40kHz rep rate, with pulse energy of >1 mJ and duration of 30 ns in Optics Express, The International Electronic Journal of Optics. The output was linearly polarized with a $M^2 < 1.2$. Liekki highly doped fiber (Yb1200-30/250DC-PM) was used in this work.

For more information, please see:

<http://www.opticsexpress.org/abstract.cfm?id=97648>

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Upgrade of the Liekki manufacturing facility



Pic. 1: DND deposition chamber

Liekki is in the process of upgrading the fiber manufacturing facility. The upgrade consists of doubling the factory deposition capacity. Nextrom gasfeed and automation technology as well as Liekki designed direct liquid sources will be used in tandem with new upgraded Liekki DND burning/deposition chambers. The new equipment includes improved control electronics/software and an improved compact design. The initial installation is well underway with production qualification due to start the end of September.

The equipment will allow Liekki to meet the growing demand for active fibers.

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Broadened list of complimentary products and services

Liekki offers a comprehensive array of products to compliment our doped fiber offerings. This includes:

- [Passive fibers](#)

For splicing to our active fibers a full line of passive fibers matching our active core and cladding geometries is available, either with low index or high index coatings. Glass coatings are currently in development for 20/400 fiber. Other dimensions are available on request.

- **Fiber Bragg Gratings**

Fiber Bragg Gratings (FBGs) are available in our LMA passive fibers as high or low reflectance. Standard configurations are 10/123, 20/123, 25/240 and 20/390 (core/cladding). Other geometries are available on request. Standard wavelengths are x,y,z, nm + a.nm. Other wavelengths are available on request.

- **Endcaps**

Endcaps are offered for cladding diameters of 125, 250 and 400 microns. They are fabricated in our passive fibers and used to expand the expand signal beam to prevent end-face damage.

- **Pump combiners**

Pump combiners are available in our passive fiber. A standard configuration is (6+1)x1 with pump fibers of 105/125 or 200/220 and input signal fibers of 6/125, 10/125, 20/125 and 20/400. Other configurations on request.

- In addition to offering all the key fiber components for fiber lasers and amplifiers we also provide splicing services.

For more information, please contact:
Mr. William Willson
Vice President Marketing and Sales
tel. +1 301 706 0315
email William.willson@liekki.com

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Liekki's Development Team - They get it done!

Liekki is proud of its multi-cultural, international team. Our development team is a great example of this, with citizenships from Finland, Romania, Russia and Germany.

Our development team includes:

- **Mikko Söderlund (Product Manager, Fibers)**

Mikko has 10 years experience with doped optical fibers and fiber amplifiers. Before joining Liekki as a product manager he has been working for the Photonics Group of the Technical Research Center of Finland (VTT) for 6 years. He graduated as M.Sc at the Helsinki University of Technology and is currently working on his Ph.D.

Email: mikko.soderlund@liekki.com

- **Joona Koponen (Product Manager, Optical Engines)**

Joona has 5 years experience as research scientist at the Photonics Group of the Technical Research Center of Finland (VTT). He has been studying fiber optics at the Technical Research Center of Finland (VTT).

Email: joona.koponen@liekki.com

- **Dr. Mircea Hotoleanu (Product Manager, LAD)**

Mircea has over 17 years R&D and technical management experience in optical fiber companies. Previously he has been working for companies such as NK Cables and Draka as well as the University of Cluj-Napoca, Romania.

Email: mircea.hotoleanu@liekki.com

- **Dr. Valery Philipov (Senior Scientist, Optical Engines)**

Valery has over 20 years experience in R&D activity with fiber sensors and laser's field. Previously he has been working for the

Optoelectronics Research Centre at the University of Southampton, UK. Valery has been graduated as Ph.D. at the St. Petersburg State Technical University, Russia.

Email: valery.philippov@liekki.com

- **Georg Wien (Laboratory Engineer)**

Georg has studied at the University of Applied Sciences in Berlin, Germany and finished his degree in 2005. The last two years he worked for Sandia Laboratories in Livermore, California U.S. with the Fiber Laser/Amplifier development group.

Email: georg.wien@liekki.com

- **Teemu Kokki (Laboratory Engineer)**

Teemu is studying optical communications at the Helsinki University of Technology, Finland and will graduate officially in October 2006. Within the last 2 years he gained work experience from several laboratories at the university.

Email: teemu.kokki@liekki.com

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Liekki web site redesign

Currently we are revising our web site in order to offer an enhanced service to our customers. On the redesigned web site there will be available new features like a product selector and a design tool. The release will be due to the beginning of October. As soon as the new web site is launched you will receive more detailed information.

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Topics in our next newsletter

In our next newsletter we will report on:

- Details about the upcoming Photonics West 2007
- Details about our broadened Optical Engine family
- Details about our erbium-ytterbium fiber product line
- New Liekki web site

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