Newsletter 3/2005 September, 2005

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Events calendar

- **SPIE Europe Symposium Optics/Photonics in Security & Defense**, Congress Centre SEC@Bruges, Bruges, Belgium, September 26 - 28.

  Product Manager Mr. Mikko Söderlund presents the paper "Design considerations for large-mode-area polarization maintaining double clad fibers" (paper nr 5987-10) on September 26 in Session 2 at 13.00 - 17.00.

  Senior Laboratory Engineer Mr. Joona Koponen presents the paper "Photodarkening in ytterbium-doped silica fibers" (paper nr 5990-04) on September 28 in Session 1 at 08.20 - 10.10.

- **NanoSolutions2005: The Premier Nanotechnology Conference for European Industry**, EXPO XXI Cologne, November 8 - 10 - Liekki's CEO Dr. Per Stenius discusses nanotechnology and photonics as an invited guest speaker.

View Events calendar

Contents of this issue

Introduction

This is the third newsletter from the team at Liekki and we hope you enjoyed the prior editions. We continue to strive to bring you value through our products and services. In this and the future editions you will also be briefed on our future product development and intellectual property topics in a separate section, "Liekki product development and IP news".

Some of the highlights of this newsletter:

- The SPIE Europe Symposium Optics/Photonics in Security & Defense, Bruges, September 26 - 28 with Liekki's two papers presented (read more)
- The Liekki University Program - Offering a high value, low cost product package for academic users (read more)
- Introducing our very high efficiency ytterbium-doped large mode area polarization maintaining (PM) fibers and adding complementary products; matched passive fibers and fiber bragg gratings (FBGs) (read more)
- Product highlight: Liekki Yb1200-20/125DC fiber for compact high-average-power fiber pulsed amplifiers (read more)
- Introducing our high power Optical Engines (Ytterbium fiber laser subassembly) (read more)
- Product highlight: Liekki Application Designer v3.0 applied to simulation of picoseconds pulse fiber amplifiers (read more)

Sincerely,
Bill Willson
Vice President, Marketing and Sales

Introduction to the conference paper "Design considerations for large-mode-area polarization maintaining double clad fibers"

Round PANDA polarization maintaining preforms have the advantage of effectively decoupling the fabrication of the preform and the stress elements, as well as opening the possibility to make large PM preforms and so scale-up production volumes. These fibers are very easy to use, and can also be applied instead of polygon cladding DC fibers - the advantage being that a round PM fiber is easier to cleave. This paper presents the key design considerations for fabrication and use of large-mode area (LMA) polarization maintaining double clad fiber based on the round PANDA type of PM fiber.

Read more | Request more information | Back to top

Introduction to the conference paper "Photodarkening in ytterbium-doped silica fibers"

This is the second paper about photodarkening in a sequence of three papers. The first paper was presented at CLEO/Europe-EQEC/Laser 2005. In the first paper we presented a method to measure photodarkening from single-mode fibers, and in this second paper we present the measurement method and results for large mode area double clad fibers. We are targeting the third paper, discussing the impact of photodarkening in different applications, for Photonics West 2006.

One of the key challenges posed on the performance and reliability of ytterbium doped amplifiers is mitigating photodarkening of the active fiber. Photodarkening manifests itself as a temporal increase in broadband absorption centered at visible wavelengths, and varies on how the active fiber has been manufactured. With the presented measurement method photodarkening can be measured from short samples of double clad fibers by monitoring loss at visible wavelengths, where the degradation is greatest. Repeatable measurement conditions are discussed, and results showing the effect of inversion to the initial photodarkening rate are presented. The initial photodarkening rate has been seen to be application dependent, namely lasers photodarken slower than ASE sources or amplifiers.

Read more | Request more information | Back to top

The Liekki University Program - Offering a high value, low cost product package for academic users

The Liekki University Program is designed to offer qualified undergraduate and graduate university programs cost efficient access to Liekki design and simulation software and fibers. The goal of the Liekki University Program is to augment existing labs with state-of-the-art products from Liekki and to build long-term relationships with universities around the world. The program provides a discounted package of different types and lengths of Liekki's highly doped erbium and ytterbium fibers, and licenses of the versatile simulation software; Liekki Application Designer.

Read more | Request more information | Back to top

Introducing our very high efficiency ytterbium-doped large mode area polarization maintaining (PM) fibers and adding complementary products; matched passive fibers and fiber bragg gratings (FBGs)

Liekki's Yb1200 product family features three highly-doped LMA fibers with polarization maintaining variants: Yb1200-10/125DC-PM, Yb1200-25/250DC-PM (optionally 30um core available) and Yb1200-20/400DC-PM. These fibers exhibit very high efficiency, excellent beam quality and high birefringence and polarization extinction ratio.

This series of active PM fibers is now greatly enhanced by several new additions and features. Firstly, the PM fibers have been improved so that birefringence >2*10-4 is guaranteed for all PM variants. Secondly, recently launched matched passive PM pigtails enable the fiber laser developer to maintain the excellent optical properties throughout the fiber laser or amplifier. These passive fibers are coated with low index fluoroacrylate which enables active fibers to be pumped through them (high-index coating also available upon request). Both PM and non-PM matched passive fibers are available. Thirdly, a single-mode double clad active PM fiber Yb1200-6/125DC-PM will be released in Q4. This fiber benefits from the good availability of off-the-shelf power combiners and other basic components required, making it an ideal "workhorse" for rapid application development.

Liekki will also shortly release a series of matched passive (PM and non-PM) photosensitive fibers with fiber bragg gratings. These passives are also low-index coated double clad fibers, so that active double clad fibers may be pumped through them thus enabling low loss all-fiber laser cavities. The FBGs will be available for all Liekki LMA fibers. All-glass variants of passive double clad FBG fibers for most demanding high-power applications are also being developed together with the active counterparts.

Request more information | Back to top

Liekki Yb1200-20/125DC fiber for compact high-average-power fiber pulsed amplifiers

Liekki has launched a highly-doped ytterbium fiber Yb1200-20/125DC, ideally suited for compact high-average-power pulsed amplifier applications where large mode area and short fiber length are critical for suppression of nonlinear effects. The fiber features high-efficiency 20um diameter core with low NA providing excellent beam quality together with a standard 125um cladding. The combination of highly doped core, large core-to-cladding ratio and efficient octagonal cladding shape provide nominal cladding absorption of 6.8dB/m at 920nm, enabling < 2m application lengths. This fiber is available off-the-shelf as a part of Liekki standard product platform. A matching 6+1-to-1 combiner with six input pump fibers (standard 105/125 size) is under development.

Request more information | Back to top

Introducing our high power Optical Engines (Ytterbium fiber laser subassemblies) - Capable of 80W CW at 1090nm

Liekki's fiber laser subassemblies - Liekki Optical Engines - are fully engineered and optimized plug-and-play fiber laser modules with a very compact packaging that includes full thermal management. Depending on the application requirements, the Liekki Optical Engines are available with either air or water cooled heat exchangers. The module is 160x15mm diameter in size and

"stackable" (Lego-like). The unit is a fully assembled all-fiber design including active and passive fibers spliced with industry standard combiners and gratings. Ready-to-splice pigtails for pumps, as well as output (and input, if used as amplifier) fibers are included, and there is also a separate "monitor" output fiber with a low power output reference beam. The output beam has a M^2~1.1 (wavelength 1070-1090nm, FWHM 0.2nm).

Request more information | Back to top

Liekki Application Designer v3.0 applied to simulate picoseconds pulse fiber amplifiers

Liekki Application Designer (LAD) v3.0 is the first commercially available software simulator to perform transient analysis of fiber lasers and amplifiers. LAD can simulate pulsed fiber amplifiers down to picoseconds time scale provided that the fly-time of the photons inside the set-up does not play a significant role in the system.

To learn how to use LAD v3.0 to simulate picoseconds scale fiber amplifiers, please read the document "How to simulate pulsed fiber amplifiers with LAD v3.0". (Available also from http://www.liekki.fi/lad in Tutorials v3.0 section).

Read more | Request more information | Back to top

Liekki product development and IP news

Active and passive fibers and fiber components

Liekki has recently demonstrated active fibers with directly written fiber bragg gratings (FBGs). This novel technology provides considerable benefits for the application designer, as it allows optical cavities to be created directly into the active fiber without splicing separate fiber bragg gratings. This reduces intra-cavity losses and allows to eliminate costly discrete components. Initial demonstrations showed reflectivity of better than 30dB. Photosensitive active fiber technology, combined with Liekki's range of large mode area DC and DC-PM fibers (available with all-glass coatings), promises to be a breakthrough for high power fiber laser applications. For more information, please contact Product Manager Dr. Valery Philippov (email: valery.philippov@liekki.com) or Vice President Marketing and Sales Mr. William Willson (email: william.willson@liekki.com).

Back to top

Design software and tools

The Liekki Application Designer (LAD) development continues. Following the fiber laser industry requirements, the new version of LAD to be released at the beginning of next year will include the analysis of the multimode propagation in the active fibers. This feature will allow more accurate simulation of large mode area fibers used in high power applications that works in near single mode regime. For more information, please contact Product Manager Dr. Mircea Hotoleanu (email: mircea.hotoleanu@liekki.com) or Vice President, Marketing and Sales Mr. William Willson (email: william.willson@liekki.com).

Back to top

Fiber laser and amplifier optical engines

Liekki is getting ready to demonstrate its highest power Optical Engine. Recent development work has resulted in a very cost effective design for a 300...500W CW fiber laser subassembly. With our partner, we have engineered this optical engine with a compact and very cost effective plug-and-play diode pump module targeting 40EUR/W price-performance. Both the optical engine and the pump module are water cooled. The target for this product is to offer the most cost effective subassembly solution for high power CW laser applications. First demonstration units will be available by the end of 2005. For further information, please contact Product Manager Dr. Valery Philippov (email: valery.philippov@liekki.com) or Vice President Marketing and Sales Mr. William Willson (email: william.willson@liekki.com).

Back to top

Intellectual property

Liekki is pleased to announce that completion of the licensing from the Naval Research Laboratory (NRL) of the helical coiling/higher order mode suppression technology developed by Sandia and NRL researchers (US patent #6,496,301 B1 "Helical fiber amplifier" by Koplow et al., Opt. Lett. 25, 442, 2000). This patent describes how large mode area (V-number greater than 4) fibers can be made to operate with diffraction-limited beam quality (M^2 ~ 1) using coiling to eliminate higher order modes. Through this license our customers using Liekki Optical Engines and fiber coils can leverage the advantages of this milestone patent. Liekki is excited about bringing this fundamental technology to commercial use, and expect our continued collaboration with Sandia researchers to result in further technology and technology licensing for the benefit of our customers and the commercial fiber application market place at large. Please contact sales@liekki.com for more detailed information.

Back to top

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