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## Introduction

2005 has successfully come to its end and we are now heading for an exciting and eventful new year! We hope that you have enjoyed our newsletter editions in 2005 and that you have found them useful.

In 2006 we will continue to strive to bring you value through our products and services. Our newsletters will cover the latest significant news and 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.

This first newsletter edition in 2006 is highlighting:

- [The Liekki presence at the SPIE Photonics West Conference, San Jose, California, January 21 - 26.](#)
- For flexible customer service Liekki now offers all customers the opportunity to place orders with the major credit cards. Please contact Mr. Bill Willson, [william.willson@liekki.com](mailto:william.willson@liekki.com), if you are interested in this service.
- [The launch of the latest version of Liekki's simulation software, Liekki Application Designer v3.1](#)
- [Developments on fibers - All-glass variant in ytterbium fibers, double cladding erbium fibers, and advanced fiber concepts](#)
- [A broadened Optical Engine \(fiber laser/amplifier subassembly modules\) product line](#)
- [A look back at Liekki's accomplishments in 2005](#)
- [A look ahead to Liekki's plans for 2006](#)

The Liekki team would like to wish you all the best for 2006 and we look forward to working with you!

Sincerely,

Bill Willson  
Vice President, Marketing and Sales  
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## Liekki's presence at the SPIE Photonics West Conference, San Jose, January 21-26

- Liekki will be presenting two papers. A post-deadline paper has also been submitted.
  - The invited conference paper "[The potential of direct nanoparticle deposition for the next generation active fibers](#)" will be presented by Product Manager, Mr. Mikko Soderlund on January 23rd (paper #6116-16).
  - The conference paper "[High order modes suppression in large mode area active fibers by controlling the radial distribution of the rare earth dopant](#)" will be presented by Product Manager, Dr. Mircea Hotoleanu on January 26th (paper #6102-64).
  - Research Scientists at the Sandia National Laboratories are

reporting recent results from Yb-doped fiber amplifiers seeded with a variety of pulsed laser sources. Using a passively Q-switched, Nd:YAG microchip laser as a sub-nanosecond seed source, Dr. Dahv Kliner, Dr. Jeff Koplow and associates demonstrated a diffraction-limited output beam ( $M^2 = 1.1$ ) and a pulse energy of up to 0.63 mJ using Liekki's Yb1200-30/250DC as the amplifying fiber.

- A post-deadline conference paper on [Photodarkening](#) has been submitted by Senior Laboratory Engineer, Mr. Joonas Koponen and Liekki co-authors. The session is currently scheduled for Tuesday Jan 24th at 4.50pm.
- Liekki will also have a suite available for product review meetings during the entire conference period in the conveniently located Fairmont Hotel at 170 South Market Street.

If you are interested in scheduling a private meeting time, please contact VP Marketing and Sales Bill Willson, [william.willson@liekki.com](mailto:william.willson@liekki.com), tel. +1 301 706 0315 or respond to [sales@liekki.com](mailto:sales@liekki.com).

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### Introduction to the invited conference paper "The potential of direct nanoparticle deposition for the next generation active fibers"

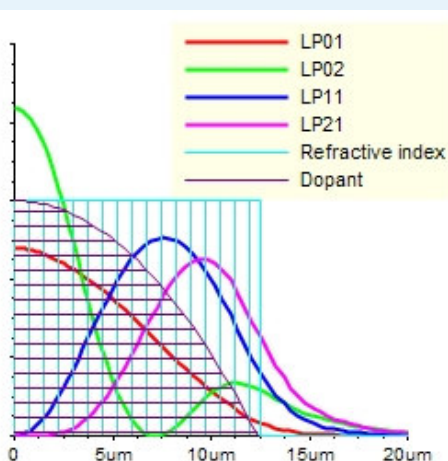
In the paper Liekki's unique and proprietary DND technology will be presented and its advantages over conventional fiber manufacturing technologies will be discussed. Also the latest results with DND active fibers will be presented and some of the new exciting possibilities enabled by DND technology for enhancing active fiber performance and functionality in fiber laser applications will be discussed.

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### Introduction to the conference paper "High order modes suppression in large mode area active fibers by controlling the radial distribution of the rare earth dopant"

Using Liekki Application Designer (LAD) we demonstrate the effectiveness of higher order modes suppression in large mode area active fibers by optimizing the rare earth dopant concentration across the core while keeping the step index structure of the core of the fiber. The traditional doped fiber manufacturing technologies are not readily able to radially control the dopant concentration. However, the DND (Direct Nanoparticle Deposition) technology has the inherent capability to manufacture large mode area fibers having any radial distribution of active element concentration and any refractive index profile. The LAD software can then be used to predict the expected performance of such advanced fiber structures.

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The paper presents the modal propagation in large mode area fibers

## Introduction to the Photodarkening post-deadline conference paper

The Photodarkening post-deadline paper summarizes recent progress as part of ongoing studies of the photodarkening process. The paper discusses some interesting results obtained using short DC fiber samples cladding pumped in the 920nm spectral region. The most recent set of measurements involves temporal evolution of photodarkening studied by measuring the transmission of a 633nm probe laser through fibers maintained at room temperature by immersion in a water bath.

We found that the photodarkening process could be described by fitting with bi-exponential kinetic curves or by a stretched exponential fit. The former was analyzed in some depth by Dr. Dahv Kliner at Sandia National Laboratories, who together with Dr. Jeff Koplów collaborated in this paper.

In either case the photodarkening rate was observed to have a near seventh-order dependence on the level of inversion, implying that high inversions are preferable for benchmarking of photodarkening in silica fibers. This would seem to support our contention that a pulsed amplifier may photodarken up to  $10^5$ - $10^7$  times faster than a CW laser, assuming average inversions of 40-50% and 5-10%, respectively.

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## A look back at 2005

2005 was a successful year for Liekki as we greatly increased our product line, market presence and manufacturing capabilities. Some of the highlights were:

- The introduction of Liekki Application Designer ([LAD](#)) versions 2.0 and 3.0, our unique simulation software for high power lasers and amplifiers. LAD is also now available for a free two week trial download.
- [A greatly expanded fiber product line including new fiber geometries such as Yb1200-20/125DC, a full PM line, all-glass claddings, matching passive or relay fibers, complimentary products such as pre-spliced endcaps, combiners and fiber bragg gratings \(FBGs\); and finally a unique product bundle for universities \(FBs\). Liekki also offers a unique product bundle for universities, including selected fiber varieties and LAD simulation software.](#)
- The introduction and expansion of our [Optical Engines](#) product line (fiber laser/amplifier subassembly modules). Features include  $M^2$  of 1.2, CW output powers up to 500W, integrated heat sinking and a compact footprint.
- [Several conference papers were presented in 2005](#) some of which focused on our groundbreaking work in understanding and mitigating Photodarkening as a potential fiber lifetime limiting process.
- Liekki received the [Frost & Sullivan's Technology Leadership Award](#) in recognition of its unique active fiber technology, Direct Nanoparticle Deposition (DND) process.
- Finally Liekki has invested significantly in its plant and equipment to improve its cycle time, quality and capacity.

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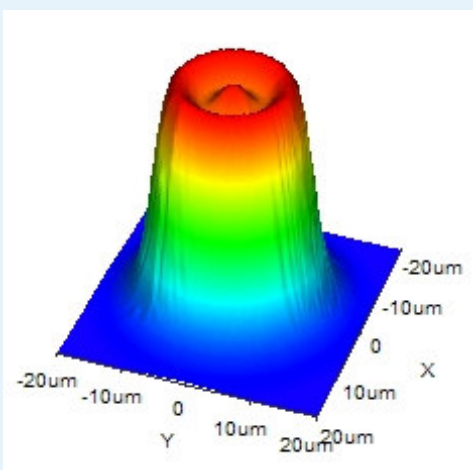
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## A look ahead to 2006

You can expect more of the same, fast paced, cutting edge innovations, from Liekki in 2006 including:

- Ongoing expansion of all of its products:
  - New versions of LAD, v3.1 and beyond
  - Expanded ytterbium fiber product line and a new LMA erbium doped product line
  - Expanded complimentary products including FBGs and combiners
  - Higher power Optical Engines of up to 500W CW and beyond
- [More conference participations and papers](#)
- Ongoing investment in the plant and infrastructure expansion in key geographic markets

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LAD v3.1 simulates the multimode propagation in rare-earth doped fibers

## Version 3.1 of Liekki Application Designer will be launched at Photonics West - Including new and essential tools for fiber laser simulation

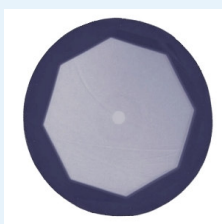
The new version of Liekki Application Designer (LAD) to be released at Photonics West'06 will include essential tools for designing systems employing large mode area fibers for the first time in a commercially available fiber amplifier and laser simulator:

- **Multimode propagation:** LAD can now calculate the optical power propagation along the doped fiber for each mode in multimode fibers. This way the user can evaluate the quality of the output optical beam.
- **Non-step refractive index profile:** LAD v3.1 can be now used to design and simulate non-step index fibers having radial symmetry.
- **Fiber bending effects:** In virtually any application, the optical fiber is bent either for packaging purposes or to discriminate against higher order modes. LAD v3.1 includes now the bending effects in the calculations including mode field distortion and power loss.

These new tools come in addition to many other existing features such as radial doping, transient calculations, Monte Carlo analysis, non-linear effects threshold power, etc. making LAD v3.1 the ultimate tool for designing and simulation fiber lasers and amplifiers!

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## Liekki product development and IP news



## Ytterbium 1200 product family to be extended with all-glass fibers

Liekki is extending its Yb1200 product family in Q1/2006 with fluorosilicate coated, all-glass active, passive and fiber bragg grating (FBG) fibers. First to be released is an all-glass variant of the popular Yb1200-20/400DC with accompanying passives and FBGs, targeting high-power industrial fiber laser applications with output powers exceeding 100W's where tolerance and reliability is critical. The active fiber cladding is optimized for accepting pump light from industry standard 400 $\mu$ m diameter cables with 0.22 NA. The supporting FBG active and passive fibers allow for assembly of low-loss, high efficiency laser cavity with pump power limited output.

An all-glass octagonal ytterbium fiber with double cladding

[View Liekki's current Fiber product map](#)

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### **Erbium double cladding fibers to be launched**

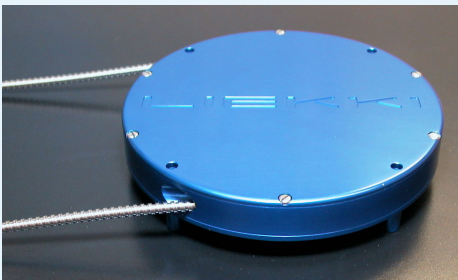
Liekki will launch a new product line of erbium doped double cladding (Er-DC) fibers in Q1/2006. The first variant to be released is based on the standard 125 $\mu$ m diameter cladding, with low NA 20 $\mu$ m diameter core. The core composition relies on Liekki's long-term experience in making highly-doped Er single-mode fibers for short pulse amplifiers. Larger cores as well as polarization maintaining variants are planned for later releases.

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### **Advanced fiber concepts including >50 $\mu$ m cores, advanced fiber combiner schemes, and radial doping in development**

In addition to planned extensions to the existing product lines, Liekki is exploiting the potential of DND technology in a number of customer-driven advanced fiber development projects where the limits of fiber lasers are being challenged. Promising efforts currently in the experimental stage include very large diameter cores (30-100 $\mu$ m) with near single-mode beam quality for high pulse energy extraction, fiber performance enhancement through modifications of the active ion doping profile for inducing preferential gain for the fundamental mode, and new fiber design developments aiming to add new functionalities to the active fiber such as beam coupling.

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OE-50 and OE-100 offer a cost effective solution for medium power range applications



OE-500-Laser offers up to 500W CW power, and is also available as a rack-mounted unit

### **Rapid development of the Optical Engine product line**

The past two months marked a rapid set of developments in the Optical Engine area. In particular, the characterization of the performance of Optical Engines pumped at increasingly high powers continues in preparation for the upcoming demonstrations with high power diodes such as Laserline's. A rack-mounted unit has now been added to our official roadmap, which will be marketed as a "Beam converter". This unit is designed for use as a plug-and-play subassembly compatible with existing rack-mounted high power diode lasers. Plans are afoot for constructing >500W units, scalable to kW - an important step for Liekki moving up the laser applications value chain.

[View Liekki's current Optical Engine product map](#)

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