Selecting the Optimal LMA Fiber

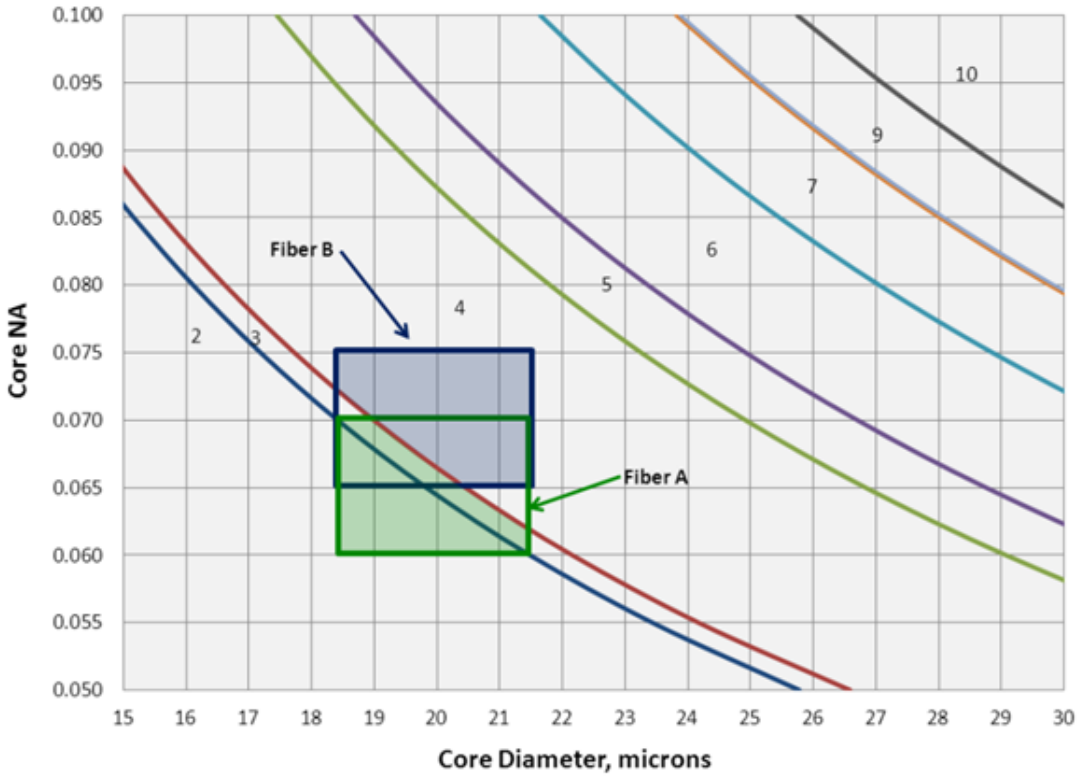
Introduction:

Several LMA fiber options are available to laser manufacturers. Understanding the tradeoffs and performance impacts of the fiber properties and characteristics is important for selecting the most appropriate fiber for the specific application. The choice of an LMA fiber for getting raw output power with limited beam quality can be different from an LMA fiber that offers high power with excellent beam quality for a marginally higher cost.

Mode Content in LMA Fibers

Some fibers may have higher absorption than others allowing the laser manufacturer to use a shorter length of fiber, potentially reducing manufacturing costs. These fibers with higher absorption often times also have larger NA which may impact beam quality. If the laser requires SM-like beam quality, the fiber should be chosen carefully based on the number of modes it supports and how easily the fiber provides excellent beam quality. For a given core size the number of modes increases with numerical aperture (NA).

Linearly Polarized Modes Supported by LMA fibers



Number of linearly polarized modes supported by fibers with different core sizes and NAs operating at 1064 nm. Lower NA fiber offers the largest operating range of fewest modes making it ideally suited for high powers while maintaining beam quality and fiber reliability.

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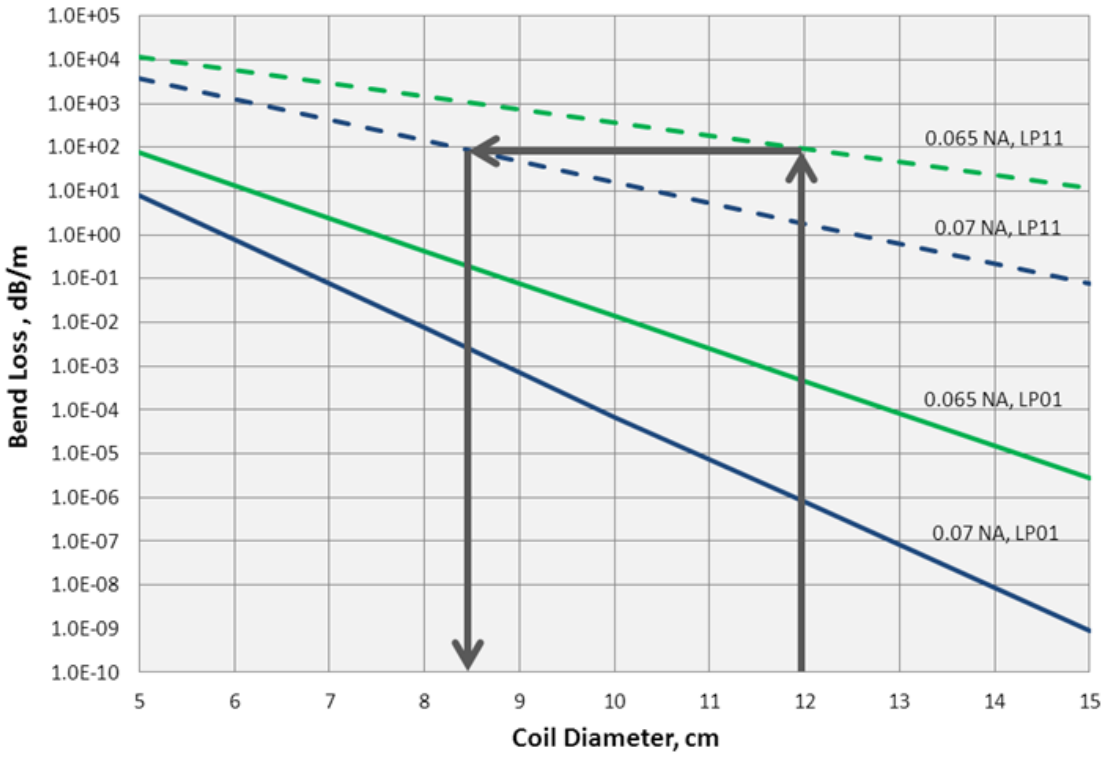
Optimizing Bend Induced Losses in LMA Fibers

In doped LMA fibers, each of the modes supported by the core can experience gain. By suppressing the gain in the higher order modes (HOM) the fundamental mode can experience preferential gain enabling a diffraction limited output beam. One of the techniques employed to suppress gain in the HOMs is to coil the fiber. For a given coil diameter the bend loss in the HOMs is greater compared to the fundamental mode. Thus by choosing an appropriate coil diameter the fundamental mode loss can be kept small while achieving high loss in the second and other higher order modes. Fibers with fewer number of modes, for a given core size, easily enable bend loss induced gain suppression of the HOMs.

Bend Loss of Fundamental and Higher Order Mode in 20/400 Fibers



LP01 and LP11 bend losses of 20 µm core diameter fibers at 1060 nm vs. coil diameter for 0.065 NA (in green) fiber and 0.07 NA (in blue) fiber. The 0.065 NA fiber has greater HOM bend loss enabling users to more easily discriminate the fundamental (LP01) mode from the HOMs making it easier to design fiber lasers with diffraction limited beam quality.

Beam Quality in High Power LMA Fiber Devices

Excellent beam quality can be achieved by similar analysis and selection of optimal LMA fibers for even larger core fibers. Near diffraction limited performance has been achieved with 0.06 NA, LMA-YDF-25/400 fibers at powers as high as 1.5 kW.

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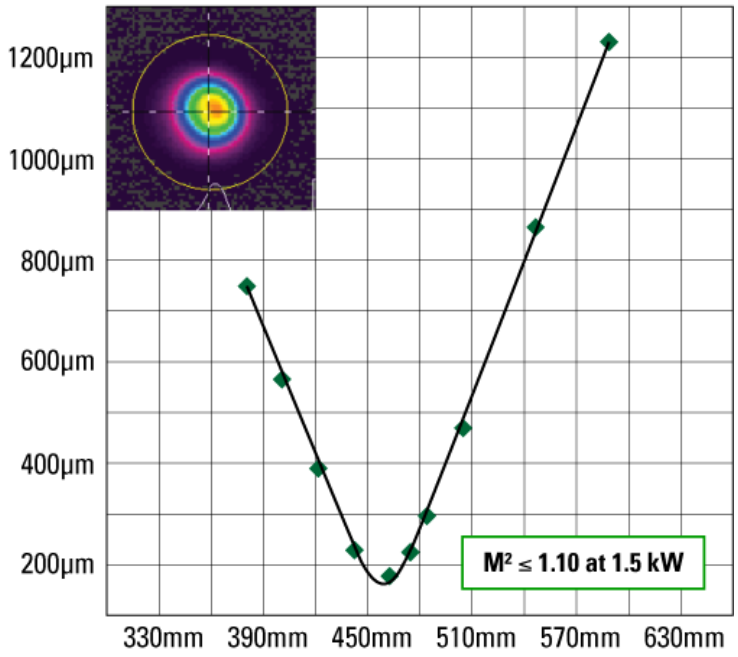
Beam Quality at High Power Achieved with an Optimal LMA-YDF-25/400 Fiber



Beam quality, M2, achieved with a 0.06 NA, 25/400 µm, Yb-fiber operating at an output power of 1500 watts. Lower NA LMA fibers deliver excellent beam quality at the highest powers.

Summary:
Laser manufacturers have several LMA fiber options to choose from. If excellent beam quality along with high power is desired, laser manufacturers must carefully select among available fibers. A discerning choice will ultimately offer the best cost-performance benefit for the targeted application.

Nufern offers a wide range of specialty fibers for industrial, medical, military, aerospace and scientific applications.

Our ongoing commitment to research and investigation with our customers promises a bright future with optical fiber technology.

We look forward to hearing from you.

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