

Yb FIBERS FOR ULTRAFAST LASERS

SOLUTION OVERVIEW

INO offers a wide range of large mode area (LMA) ytterbium-doped optical fibers. The exceptional beam quality of our fibers is well adapted for every amplification stage.

	OPTICAL FIBER				TAPERED FIBER
	Yb401-PM	Yb-10/125-1.6-PM	Yb-15/125-2.7-PM	Yb-35/250-2.5-PM	Yb-35/250-56/400-2.2-T0.7-PM
Optical cladding	Single	Multiple	Double	Multiple	Multiple Optical Cladding
Core diameter	5 μm	10 μm	15 μm	35 μm	Input: 35/250 μm
Cladding diameter	125 μm	125 μm	125 μm	250 μm	Output : 56/400 μm
Core NA	0.14	0.08	0.08	0.07	Core NA: 0.07
Absorption @ 915 nm	140 dB/m	1.6 dB/m	2.7 dB/m	2.5 dB/m	Absorption at 915 nm: 2.2 dB/m
Coiling diameter	-	-	≥ 6 cm	≥ 14 cm	Coiling Diameter: 20 $\rightarrow$ 40 cm
Features	- Adapted for low power lasers and amplifiers - Low photo-darkening core chemistry				- Designed for output M^2 lower than 1.2 - Large core diameter - Low photodarkening - High birefringence - Confined core for selective gain amplification - Depressed cladding design for enhanced differential bending losses



Yb401-PM

Yb-DOPED SINGLE CLAD PM FIBER

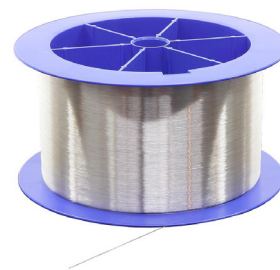
SOLUTION OVERVIEW

The Yb401-PM is a single-clad and truly single-mode polarization-maintaining fiber featuring a 6.0 μm MFD @ 1060 nm, a core absorption of 140 dB/m @ 915 nm and low photodarkening core chemistry.

This fiber is well adapted for low power pulsed amplifiers pumped using single-mode laser diodes. The Yb401-PM is a low-photodarkening drop-in equivalent of the Yb501-PM fiber.

TYPICAL APPLICATIONS

- Low power pulsed amplifiers



MAIN SPECIFICATIONS

OPTICAL PROPERTIES		PHYSICAL PROPERTIES	
Core NA	0.14 ± 0.02	Optical cladding	Single
Mode field diameter @ 1060 nm	6.0 ± 1.0	Core diameter	$5.0 \pm 0.5 \mu\text{m}$
LP11 cut-off wavelength	800 - 900 nm	Cladding diameter	$125 \pm 1 \mu\text{m}$
Core absorption @ 915 nm	$140 \pm 25 \text{ dB/m}$	Coating diameter	$250 \pm 10 \mu\text{m}$
Nominal core absorption @ 975 nm	600 dB/m	Cladding geometry	Round
Birefringence	$\geq 3.0 \times 10^{-4}$	Low photodarkening chemistry	Yes
		Screen proof tested	$\geq 100 \text{ kpsi}$
		Confined core	No
		Depressed cladding	No

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Yb-MCOF-10/125-08-1.6-PM

Yb-DOPED PM FIBER

SOLUTION OVERVIEW

The Yb-MCOF-10/125-08-1.6-PM fiber is a PM, multicladd singlemode fiber based on a low photodarkening core glass host ensuring long-term performances. Its singlemode output design makes it the perfect choice for pulsed fiber lasers and amplifiers requiring superior beam quality.

FEATURES

- Single-mode output design
- High birefringence
- Low photodarkening

TYPICAL APPLICATIONS

- Pulsed fiber amplifiers and lasers
- Frequency conversion
- Material processing



MAIN SPECIFICATIONS

OPTICAL PROPERTIES	
Core NA	0.08 ± 0.01
Cladding NA	> 0.47
Pump guide absorption @ 915 nm	1.6 ± 0.3 dB/m
Nominal pump guide absorption @ 975 nm	6 dB/m
Birefringence	$\geq 2.0 \times 10^{-4}$

PHYSICAL PROPERTIES	
Optical Cladding	Multi
Core diameter	10 ± 1 μ m
Silica cladding diameter	125 ± 1 μ m
Coating diameter	245 ± 10 μ m
Cladding geometry	Round
Core/clad concentricity error	< 1 μ m
Screen proof tested	100 kpsi
Confined core	No
Depressed cladding	No

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Yb-DCOF-15/125-08-2.7-PM

Yb-DOPED PM FIBER

SOLUTION OVERVIEW

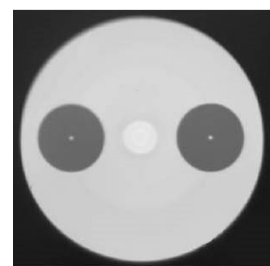
The Yb-DCOF-15/125-08-2.7-PM fiber is a PM, double-clad fiber, featuring a 15 μm core diameter and high absorption, with a low photodarkening core glass host ensuring long-term performances. Its near-diffraction-limited output design makes it the perfect choice for pulsed fiber lasers and amplifiers requiring superior beam quality.

FEATURES

- Near-diffraction-limited output design
- High birefringence
- High absorption for short amplifier length, high energy per pulse
- Low photodarkening

TYPICAL APPLICATIONS

- Pulsed fiber amplifiers and lasers
- Frequency conversion
- Material processing



MAIN SPECIFICATIONS

OPTICAL PROPERTIES	
Core NA	0.08 ± 0.01
Cladding NA	> 0.47
Pump guide absorption @ 915 nm	$2.7 \pm 0.3 \text{ dB/m}$
Nominal pump guide absorption @ 975 nm	10 dB/m
Birefringence	$\geq 1.8 \times 10^{-4}$

PHYSICAL PROPERTIES	
Optical Cladding	Double
Core diameter	$15 \pm 1 \mu\text{m}$
Silica cladding diameter	$125 \pm 1 \mu\text{m}$
Coating diameter	$245 \pm 5 \mu\text{m}$
Cladding geometry	Round
Core/clad concentricity error	$< 0.5 \mu\text{m}$
Screen proof tested	100 kpsi
Confined core	No
Depressed cladding	No

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Yb-MCOF-35/250-07-2.5-PM

Yb-DOPED LARGE MODE AREA PM FIBER

SOLUTION OVERVIEW

The Yb-MCOF-35/250-PM fibers are designed for M^2 lower than 1.15, making it the perfect choice for applications requiring superior beam quality. Our fiber design features a confined core for selective gain amplification and multi-layer cladding for superior suppression of higher order modes.

FEATURES

- Designed for output M^2 lower than 1.15
- Large core diameter of 35 μm
- Low photodarkening
- High birefringence
- Confined core for selective gain amplification
- Increased differential bending losses

TYPICAL APPLICATIONS

- Material processing
- Frequency conversion
- Biophotonics
- Range finding
- Material processing



MAIN SPECIFICATIONS

OPTICAL PROPERTIES	
Core NA	0.07 ± 0.01
Cladding NA	> 0.47
Pump guide absorption @ 915 nm	$2.5 \pm 0.5 \text{ dB/m}$
Nominal pump guide absorption @ 975 nm	10 dB/m
Birefringence	$\geq 1.4 \times 10^{-4}$
Beam quality factor M^2	< 1.15

PHYSICAL PROPERTIES	
Optical cladding	Multi
Core diameter	$35 \pm 3 \mu\text{m}$
Silica cladding diameter	$250 \pm 5 \mu\text{m}$
Coating diameter	$390 \pm 20 \mu\text{m}$
Cladding geometry	Round
Screen proof tested	$\geq 100 \text{ kpsi}$
Recommended coiling diameter	$\geq 14 \text{ cm}$
Confined core	Yes
Depressed cladding	Yes

MAIN SPECIFICATIONS CONTINUED

2 versions of this fiber are available. Please refer to the table below for specifications comparison.

OPTICAL PROPERTIES	Yb-MCOF-35/250-07-0.9-PM	Yb-MCOF-35/250-07-2.5-PM
Core NA	0.07 ± 0.01	0.07 ± 0.01
Cladding NA	>0.47	>0.47
Pump guide absorption @ 915 nm	0.9 ± 0.1 dB/m	2.5 ± 0.5 dB/m
Nominal pump guide absorption @975 nm	4 dB/m	10 dB/m
Birefringence	$\geq 1.4 \times 10^{-4}$	$\geq 1.4 \times 10^{-4}$
Beam quality factor M^2	< 1.15	< 1.15

PHYSICAL PROPERTIES	Yb-MCOF-35/250-07-0.9-PM	Yb-MCOF-35/250-07-2.5-PM
Optical cladding	Multi	Multi
Core diameter	35 ± 3 µm	35 ± 3 µm
Silica cladding diameter	250 ± 5 µm	250 ± 5 µm
Coating diameter	390 ± 10 µm	390 ± 10 µm
Cladding geometry	Round	Round
Screen proof tested	≥ 100 kpsi	≥ 100 kpsi
Recommended coiling diameter	≥ 14 cm	≥ 14 cm
Confined core	Yes	Yes
Depressed cladding	Yes	Yes

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Yb-MCOF-40/250-07-3.0-PM

Yb-DOPED LARGE MODE AREA PM FIBER

SOLUTION OVERVIEW

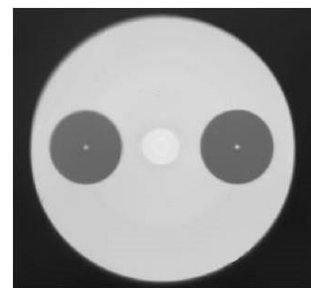
The Yb-MCOF-40/250-07-3.0PM fiber is designed for M^2 lower than 1.2, making it the perfect choice for applications requiring superior beam quality. Our fiber design features a confined core for selective gain amplification and multi-layer cladding for superior suppression of higher order modes.

FEATURES

- Designed for output M^2 lower than 1.2
- Large core diameter of 40 μm
- Low photodarkening
- High birefringence
- Confined core for selective gain amplification
- Increased differential bending losses

TYPICAL APPLICATIONS

- Material processing
- Frequency conversion
- Biophotonics
- Range finding
- Material processing



MAIN SPECIFICATIONS

OPTICAL PROPERTIES	
Core NA	0.07 ± 0.01
Cladding NA	>0.47
Pump guide absorption @915 nm	$3.0 \pm 0.5 \text{ dB/m}$
Nominal pump guide absorption @975 nm	12 dB/m
Birefringence	$>1.4 \times 10^{-4}$
Beam quality factor M^2	<1.2

PHYSICAL PROPERTIES	
Optical cladding	Multi
Core diameter	$40 \pm 3 \mu\text{m}$
Silica cladding diameter	$250 \pm 5 \mu\text{m}$
Coating diameter	$390 \pm 20 \mu\text{m}$
Cladding geometry	Circular
Screen proof tested	$\geq 100 \text{ kpsi}$
Recommended coiling diameter	$\geq 18 \text{ cm}$
Confined core	Yes
Depressed cladding	Yes

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Yb-MCOF-35/250-56/400-07-2.2-T0.7-PM

YB-DOPED LARGE MODE AREA TAPERED PM OPTICAL FIBER

SOLUTION OVERVIEW

The Yb-MCOF tapered fiber is designed for M^2 lower than 1.2 making it the perfect choice for applications requiring superior beam quality. Our fiber design features a confined core for selective gain amplification and multi-layer cladding for enhanced suppression of higher order modes.

MAIN SPECIFICATIONS

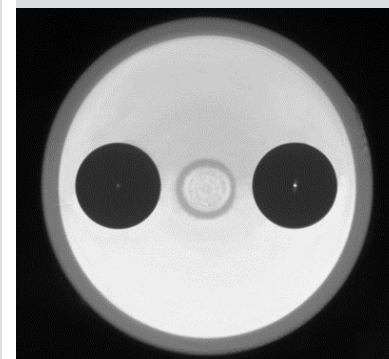
OPTICAL PROPERTIES		PHYSICAL PROPERTIES	
Core NA	0.07 ± 0.01	Taper length	0.7 ± 0.2 m
Cladding NA	> 0.47	Non-tapered sections length	> 1.0 m
Pump guide absorption @ 915 nm	2.2 ± 0.5 dB/m	Small core diameter	35 ± 3 μ m
Nominal pump guide absorption @ 975 nm	8 dB/m	Small cladding diameter	250 ± 10 μ m
Birefringence	$\geq 1.4 \times 10^{-4}$	Small coating diameter	500 ± 30 μ m
Beam quality factor M^2	< 1.2	Large core diameter	56 ± 5 μ m
		Large cladding diameter	400 ± 20 μ m
		Large coating diameter	520 ± 30 μ m
		Confined core	Yes
		Depressed cladding	Yes

FEATURES

- Designed for output M^2 lower than 1.2
- Large core diameter
- Low photodarkening
- High birefringence
- Confined core for selective gain amplification

TYPICAL APPLICATIONS

- High peak power lasers
- Ultrafast amplifiers
- Frequency conversion





LaserNGN-40mini HIGH-POWER GAIN MODULE

SOLUTION OVERVIEW

INO LaserNGN-40mini is optimized for high peak power and high average power applications. The optical fiber at the heart of the gain module is based on our low photodarkening core chemistry and features a distinctive and proprietary refractive index profile. The result is a gain module that can be operated at up to 100 W of average output power, with excellent beam quality and good polarization maintenance. The module can be easily integrated to a pigtailed oscillator with its standard 10/125 PM input fiber.

The module integrates everything needed to handle power, high thermal load and high peak fluence pulses:

- 40 μm core diameter output
- large endcap
- liquid cooled

APPLICATIONS

- High power ultrafast fiber laser
- Frequency conversion

FEATURES

- Singlemode-like output
- Easy to integrate
- Liquid cooled
- Robust construction
- Long lifetime, TMI-free operation

BENEFITS

- High nonlinear threshold
- High peak power
- High average power
- High gain
- Excellent beam quality
- Good polarization maintaining capabilities
- Broad gain bandwidth
- Excellent optical-to-optical efficiency



MAIN SPECIFICATIONS

PARAMETERS	SPECIFICATIONS	NOTES
Rated Average power*	100W	
M ²	≤1.15 (CMOS - ISO Standard 11146)	Measured with a 33mm EFL plano-convex spherical lens for collimation
Beam diameter	2 mm (typical)	Measured 60 cm from the collimating lens (33mm EFL plano-convex spherical lens)
Wavelengths	1030nm, 1064nm	
Pumps (λ, φ, NA, #)	976nm, 105/125 0.22, 2x	
Input fiber	PM 10/125 NA 0.08	
Pumping configuration	Co-pumping	
Gain*	<26dB	
PER	≥16dB	(at 1064nm)
Polarization orientation	Vertical, perpendicular to the module	
High power termination	8 x 16.5 mm endcap, AR coated	
Recommended module temperature	20±5°C	
Efficiency	≥75%	
Environmental Compliance	RoHS, REACH	
Peak power class*	200kW (Actual performance depends on seed power, seed spectral characteristics and seed temporal format)	
Power stability	≤ 1% over 8h	
Dimensions (AA x CC x DD mm ³)	254x250x11 mm ³	(without cold plate)
Dimensions (AA x CC x DD mm ³)	254x250x34 mm ³	(with cold plate)
Weight (without cold plate)	<1.4kg	
Weight (with cold plate)	<2.3kg	
Temperature (non-operationnal)	-20°C à 55°C	
Transport (non-operationnal)	MIL-STD810H 514.8C-3 Category 4 MIL-STD810H 516.8	

* Based on 300mW seed power

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LaserNGN-56

HIGH-POWER GAIN MODULE

SOLUTION OVERVIEW

INO LaserNGN-56 is optimized for high peak power and high average power applications. The tapered optical fiber at the heart of the gain module is based on our low photodarkening core chemistry and features a distinctive and proprietary refractive index profile. The result is a TMI-free operation at up to 100 W of average output power, with excellent beam quality and good polarization maintenance. The module can be easily integrated to a pigtailed oscillator with its standard 10/125 PM input fiber.

The module integrates everything needed to handle power, high thermal load and high peak fluence pulses:

- 56 μm core diameter output
- large endcap
- liquid cooled
- robust pump stripper

APPLICATIONS

- High power ultrafast fiber laser
- Frequency conversion

FEATURES

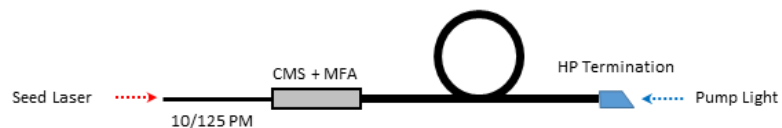
- Singlemode-like output
- Easy to integrate
- Liquid cooled
- Robust construction
- Long lifetime, TMI-free operation

BENEFITS

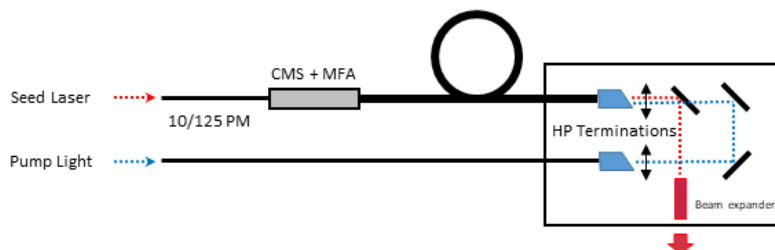
- High nonlinear threshold
- High peak power
- High average power
- High gain
- Excellent beam quality
- Good polarization maintaining capabilities
- Broad gain bandwidth
- Excellent optical-to-optical efficiency

LASERNGN-56 GAIN MODULE

Counter-pumping



Counter-pumping with the pump injection module



Schematic representation of the LaserNGN-56 gain module

MAIN SPECIFICATIONS

PARAMETERS	SPECIFICATIONS	NOTES
Amplifier Fiber	Yb-MCOF-35/250-56/400-07-2.2-T0.7-PM	
Rated Output Power	100 W	
Gain	30 dB max @ 1064 nm	
Peak Power Class	500 kW max	Actual performance depends on the pumping wavelength, pumping configuration, seed wavelength, seed power, seed spectral characteristics and seed temporal format .
Input Pump Power Counter-Pumping	150 W total max	400 μ m , NA <0.15 or equivalent brightness
Pumping Wavelength	976 nm wavelength-locked	
Gain Bandwidth	1020-1080 nm	
M ²	<1.3 (D4 σ)	ISO Standard 11146
Polarization Extinction Ratio	>16 dB	
Slope Efficiency	>70% @ 1064 nm	
Recommended Seeding Power	>500 mW	>500mW seeding power is recommended for operation at 100W output power. Lower seeding power is acceptable when operating the module at lower output power.
Input Fiber	10/125 μ m	Low NA, PM
High Power Terminaison	Integrated to the module	10 x 10 mm endcap, angle polished (2°) & AR coated
Dimensions	481 X 451 X 29 mm ³	
Case Temperature	20 +/- 2°C	Cooling liquid temperature
Cooling	Water cooled	Minimum flow rate > 2 L/min

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