Photoinscription of LPGs using FemtoLaser

Femtosecond-written long-period gratings in fluoride fibers - M.Heck et.al

Experimental conditions:

- Ti:saphire laser system emitting $100fs$ at $792nm$. Numerical aperture 0.42
- Perfectly aligned using weights
- Raley Lengths $2z_r = 4.3\mu m$ and $2\omega \approx 1.2\mu m$
- variable attenuator in combination with polarizer to adjust pulse energy.
- Fiber adjustment made with 2 Thorlab Z825B motors for XY translation ($20nm$ step size)
- Translation stage Aerotech ABL20020.
- Two cameras, one on top of the objective and the second perpendicular to the fiber.
- The grating modulation Λ adjusted with an external mechanical shutter.

The fiber used was a double clad Er^{3+}:ZrF_4 with 7mol % Er^{3+} doped core. Core diameter of $16\mu m$, surounded by a $260\mu m$ diameter glass cladding with two parallel flats separated by $240\mu m$. Exposure parameters: $250KHz$ repetition rate, $1\mu j$ of pulse energy, and $20\mu m/s$ translation speed. Grating period of $630\mu m$ with duty cycle 50%. Total grating length of $75mm$ and 120 grating elements. Energy $\varepsilon = 1\mu J$ per pulse ?

Femtosecond laser inscription of LPFG - Alexey, et.al

Experimental conditions:

- Femtosecond laser of wavelength $1026nm$ with pulse width $232fs$ and pulse repetition rate of $1KHz$. Numerical aperture 0.3.
- High precision 3D linear stage Aerotech ABL1000 with $\pm 200nm$ accuracy along X-axis. Fiber strapped by 2 clamps.
- Using SMF-28e+ fibers.
- each grating is $14mm$ in length with period of $670\mu m$ with energies $\varepsilon = \{0.7\mu J, 0.9\mu J\}$ for slits of size $1.5mm$ and $0.75mm$ slits.

A shutter is used to control the LPG period and positionnement is made with a CCD camera.

Femtosecond laser fabrication of LFPG by transversal scanning method - X.Dong et.al

Experimental conditions:

- $800mm$ femtosecond laser with pulse width of $120fs$ and $1KHz$.
- Focused to the core using lens and a 0.25 NA.
- 5 axis computer translation stage with resolution of $5nm$.
- Inscription is monitored by a CCD camera.
- Energy deployed before the microscope objective is $1.8mW$
- Optical fiber is a standard SMF-28 with core diameter of $8.2\mu m$ and cladding diameter of $125\mu m$.
- Inscription transversal speed is $50\mu s$

Fabrication of LPG in pure silica by femtosecond laser - F.Ahmed, et.al

Experimental conditions:

- Femtoscond laser of $800nm$ with pulse width of $120fs$ and repetition rate of $1KHz$.
- Computer controlled half-wave polarizer used to control the pulse energy.
- Iris diaphragm used to control the beam diameter to $1.5mm$. Then focused by an objective lens with 0.55 NA to increase pulse peak power.
- Electronic shutter used to control the laser pulses.
- A computer controlled 4-axis stage used to align the fiber with sub-micron precision.
- Grating period $\Lambda = 453\mu m$ with sub-period $\Lambda_{sub} = 1\mu m$ and sub-length $L_{sub} = 100\mu m$
- Transverse inscription speed of $50\mu m/s$ and pulse energy of $0.96\mu J$.

EPFL femtosecond laser LPG in SMF-28 - M.Douay et.al

Experimental conditions:

- Femtoscond laser of $800nm$ with pulse width of $160fs$ and repetition rate of $200KHz$.
- Collimating telescope shutter used to control the pulse energy.
- polarizer objective with NA of 0.1.
- Translation plate used with transverse speed of $2.7\mu m/s$.
- Energy of $0.27\mu J$ per pulse.
- Grating period $\Lambda = 450\mu m$ and duty-cyle of $\alpha = 0.5$

Second experiment:

- Femtosecond laser of $400nm$ with pulse width of $250fs$ and repetition rate of $248.4kHz$.
- 20x objective with NA of $0.4(f = 8.55mm)$.
- Translation stage velocity of $0.18mm/min$.
- Beam width of $6\mu m$, pulse fluence of$1.7J/cm^2$, peak intensity of $6.9 \cdot 10^{12}W/cm^2$ and dose of $1.02MJ/cm^2$
- Grating period $\Lambda = 450\mu m$ with duty cycle of 0.5 and length of $18.675mm$.

Femtosecond laser fabrication of LPFG - B.Li et.al

Experimental conditions:

- Femtosecond laser of $800nm$ with pulse width of $35fs$ and repetition rate of $1KHz$.
- 6-Axis translation stage with $1\mu m$ resolution.
- Laser focused by 20x objective with 0.45 NA.
- Beam diameter of $2\mu m$ and pulse energy $\varepsilon = 0.1 - 0.4\mu J$
- SMF-28e fiber
- Grating sub-period of $2\mu m$