“I managed to illuminate the interior of a stream in a dark space. I have discovered that this strange arrangement offers one of the most beautiful, and most curious experiments that one can perform in a course on Optics.”

Daniel Colladon, Comptes Rendus, 15, 800–802 (1842)
D. Colladon, *La Nature*, 325 (1884)
Outline

• silica nanowires
• fs laser micromachining
• biophotonics
Silica nanowires

two-step drawing process

standard fiber
Silica nanowires

two-step drawing process

standard fiber
Silica nanowires

two-step drawing process

standard fiber

1-μm silica wire

drawing
Silica nanowires

two-step drawing process

standard fiber

1-μm silica wire

drawing

sapphire taper
Silica nanowires

two-step drawing process

standard fiber

drawing

1-μm silica wire

flame

sapphire taper

silica wire
Silica nanowires

two-step drawing process

standard fiber → drawing → 1-μm silica wire

flame

sapphire taper → silica wire
Silica nanowires

two-step drawing process
Silica nanowires
Silica nanowires

1 µm

Silica nanowires
Silica nanowires
Silica nanowires
Silica nanowires
Silica nanowires
Silica nanowires
Silica nanowires

10 µm
Silica nanowires
Silica nanowires

312 nm

1 μm
Silica nanowires

Specifications

diameter $D$: down to 20 nm

length $L$: up to 90 mm

aspect ratio $D/L$: up to $10^6$

diameter uniformity $\Delta D/L$: $2 \times 10^{-6}$

Silica nanowires

d = 260 nm
L = 4 mm
Silica nanowires

2 µm
Silica nanowires
Silica nanowires

20 µm

20 µm
Optical properties

50 µm
Optical properties
Optical properties

100 µm
Outline

- silica nanowires
- fs laser micromachining
- biophotonics
Femtosecond micromachining

high intensity at focus...

100 fs

objective
transparent material
Femtosecond micromachining

...causes nonlinear ionization...

100 fs

objective

transparent material
and ‘microexplosion’ causes microscopic damage...
Femtosecond micromachining

Some applications:

• data storage
• waveguides
• microfluidics
Low-energy machining

waveguide micromachining

Low-energy machining

waveguide micromachining

Low-energy machining

structures guide light

Outline

• silica nanowires
• fs laser micromachining
• biophotonics
Applications

actin fiber network of a live cell
Applications

cut a single fiber bundle
Applications

cut a single fiber bundle

10 µm
gap widens with time
Applications

dynamics provides information on *in vivo* mechanics
Applications
Applications
great tool for

- “wiring light”
- micromanipulating the machinery of life
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