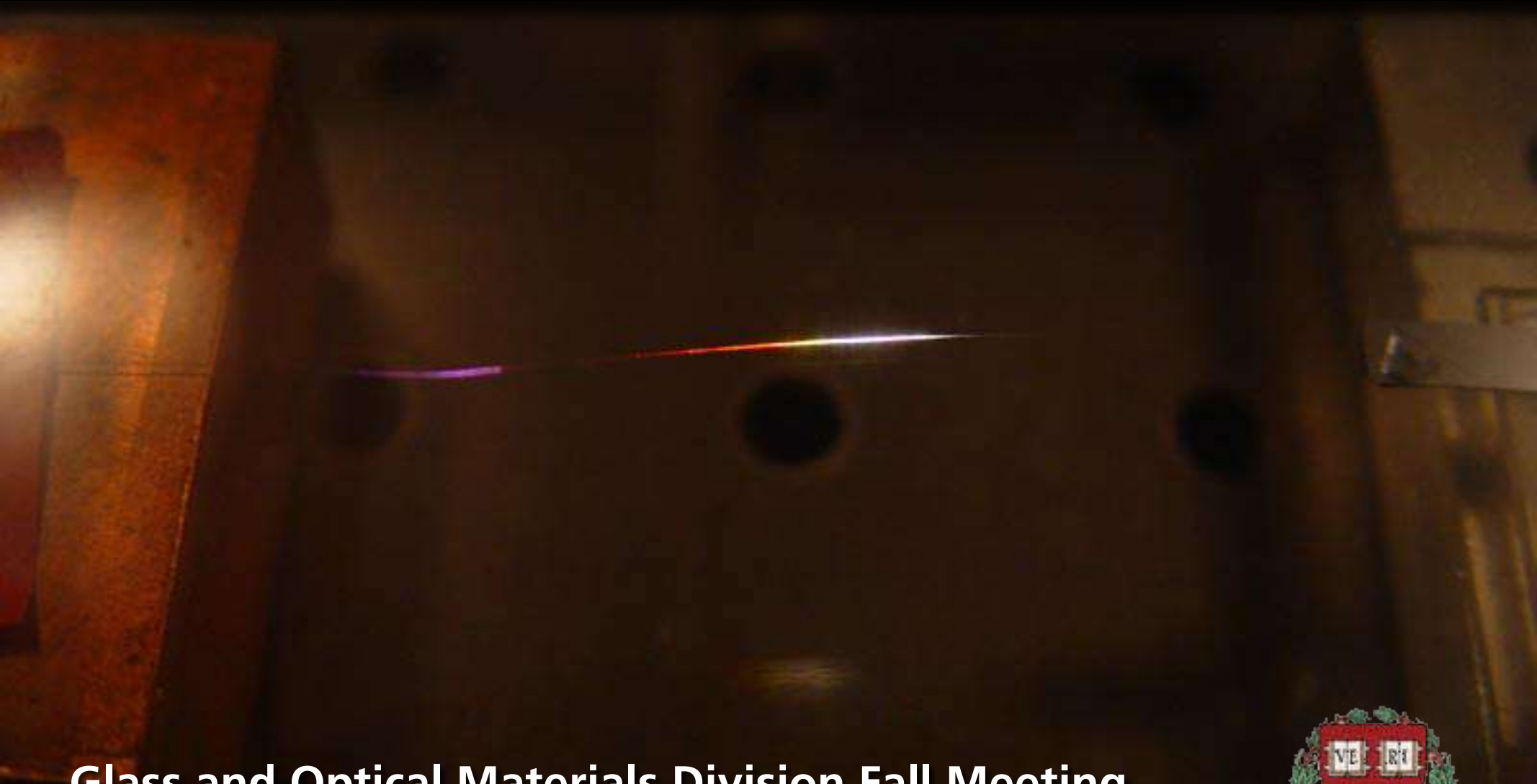
Supercontinuum and second harmonic generation in amorphous silica nanowires



Glass and Optical Materials Division Fall Meeting
Cape Canaveral, FL, 8 November 2004

Limin Tong

Rafael Gattass

Geoff Svacha

Eric Mazur

and also....

at Harvard:

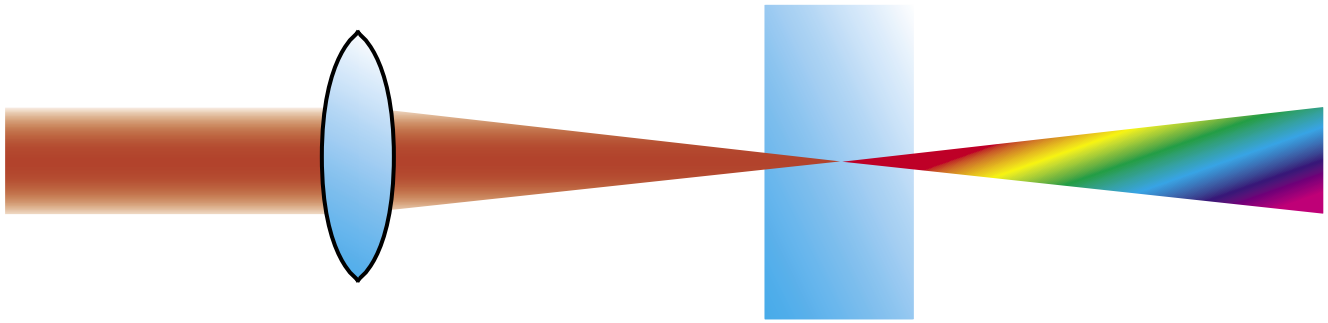
Tomasso Baldacchini
Albert Tsao
Jonathan Aschom
Mengyan Shen
Iva Maxwell
James Carey
Brian Tull
Dr. Yuan Lu
Dr. Richard Schalek

at Zhejiang University:

Dr. Sailing He
Dr. Jingyi Lou
Xuewen Chen
Liu Liu
Zhanghua Han

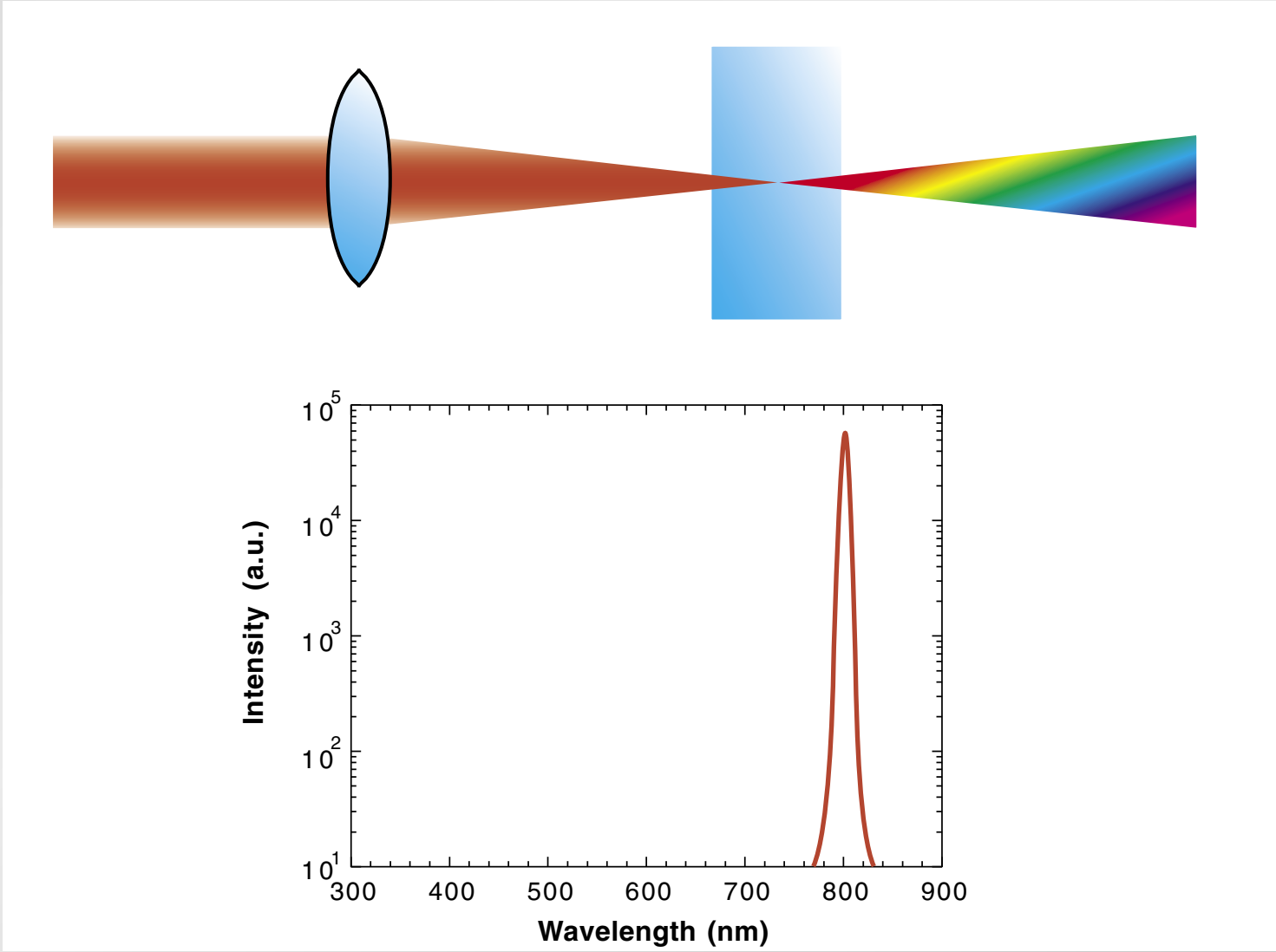
Motivation

conventional supercontinuum generation



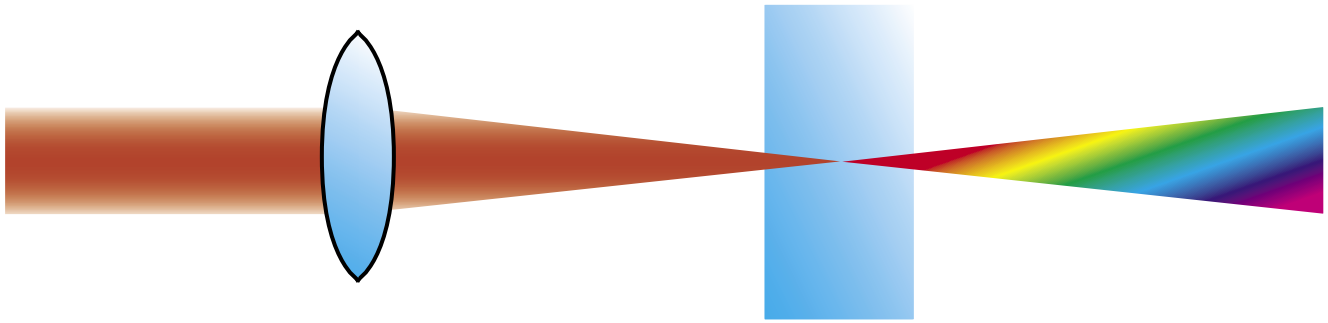
Motivation

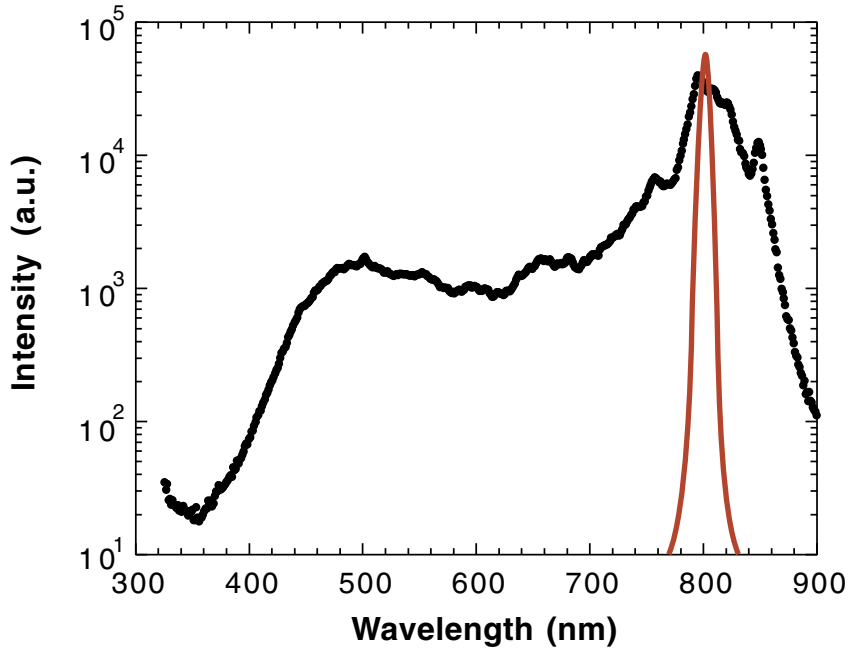
conventional supercontinuum generation



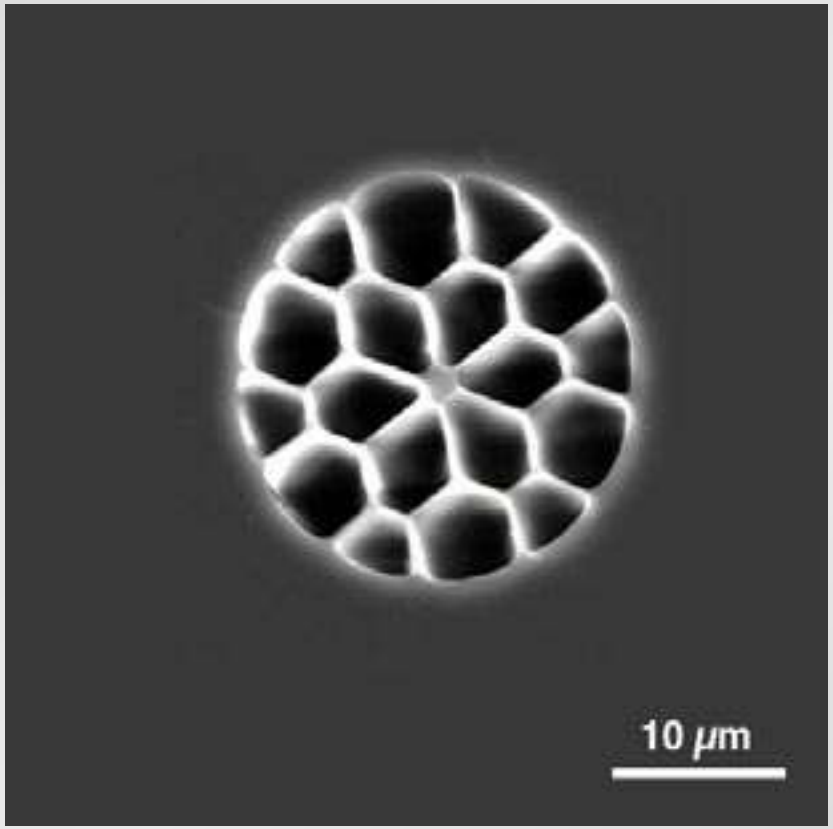
Motivation

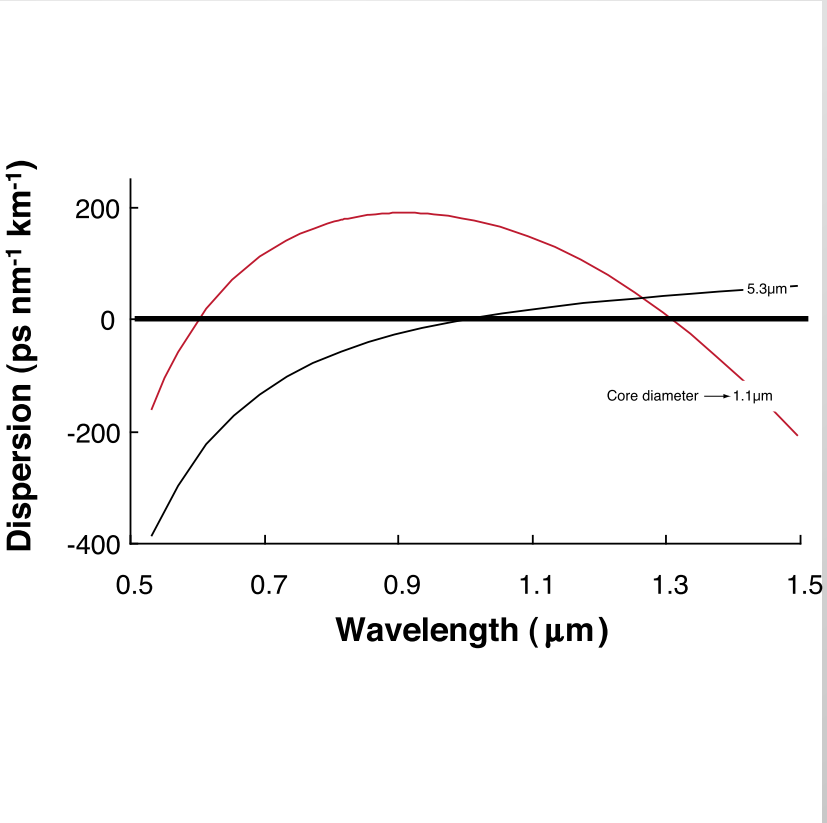
conventional supercontinuum generation





Motivation


10 μm


Dispersion (ps nm-1 km-1)
200
0
-200
-400
0.5
0.7
0.9
1.1
1.3
1.5
Wavelength (μm)
5.3μm
Core diameter → 1.1μm

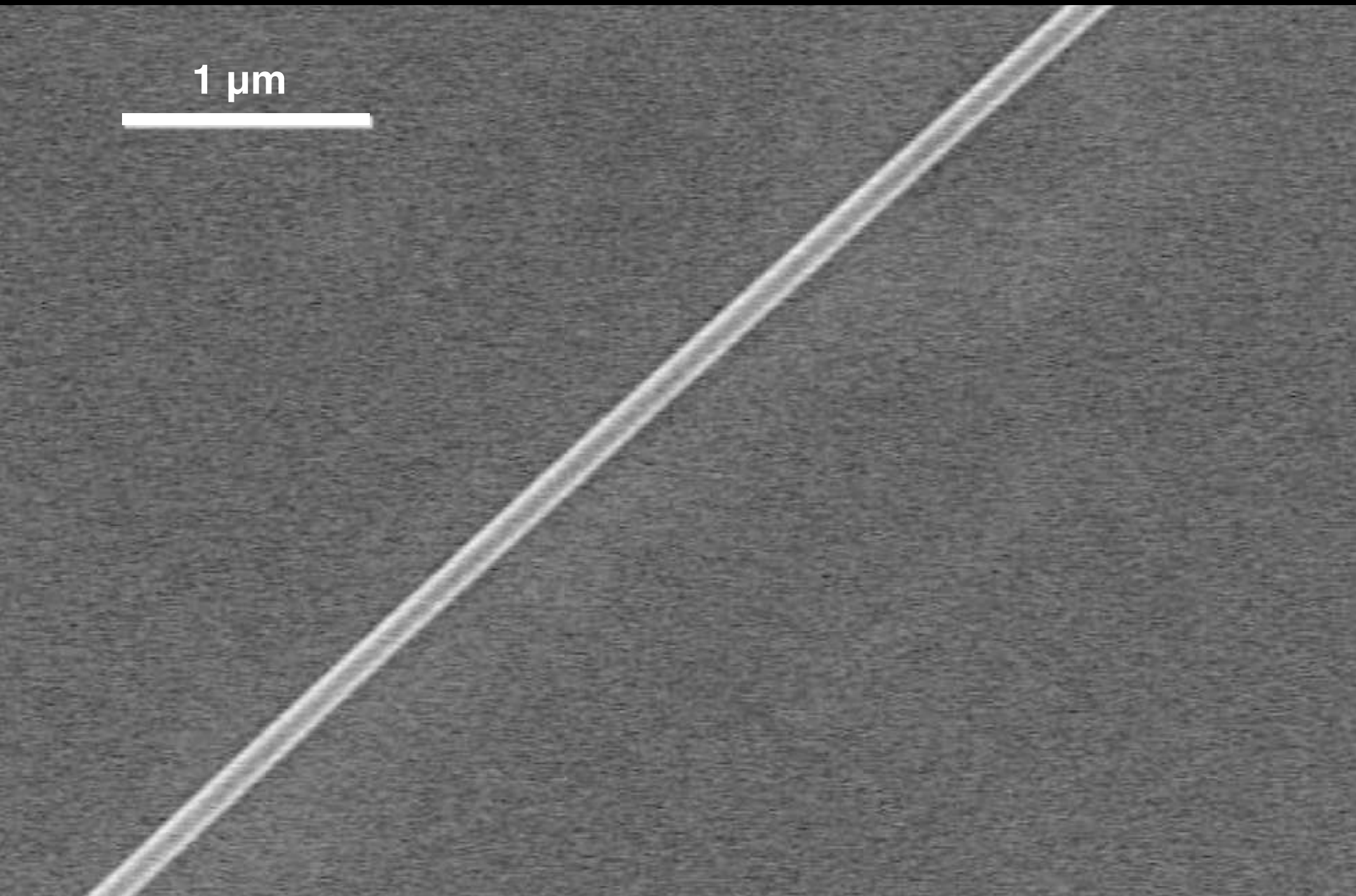
Outline

- nanowire fabrication
- optical properties
- supercontinuum spectra

Outline

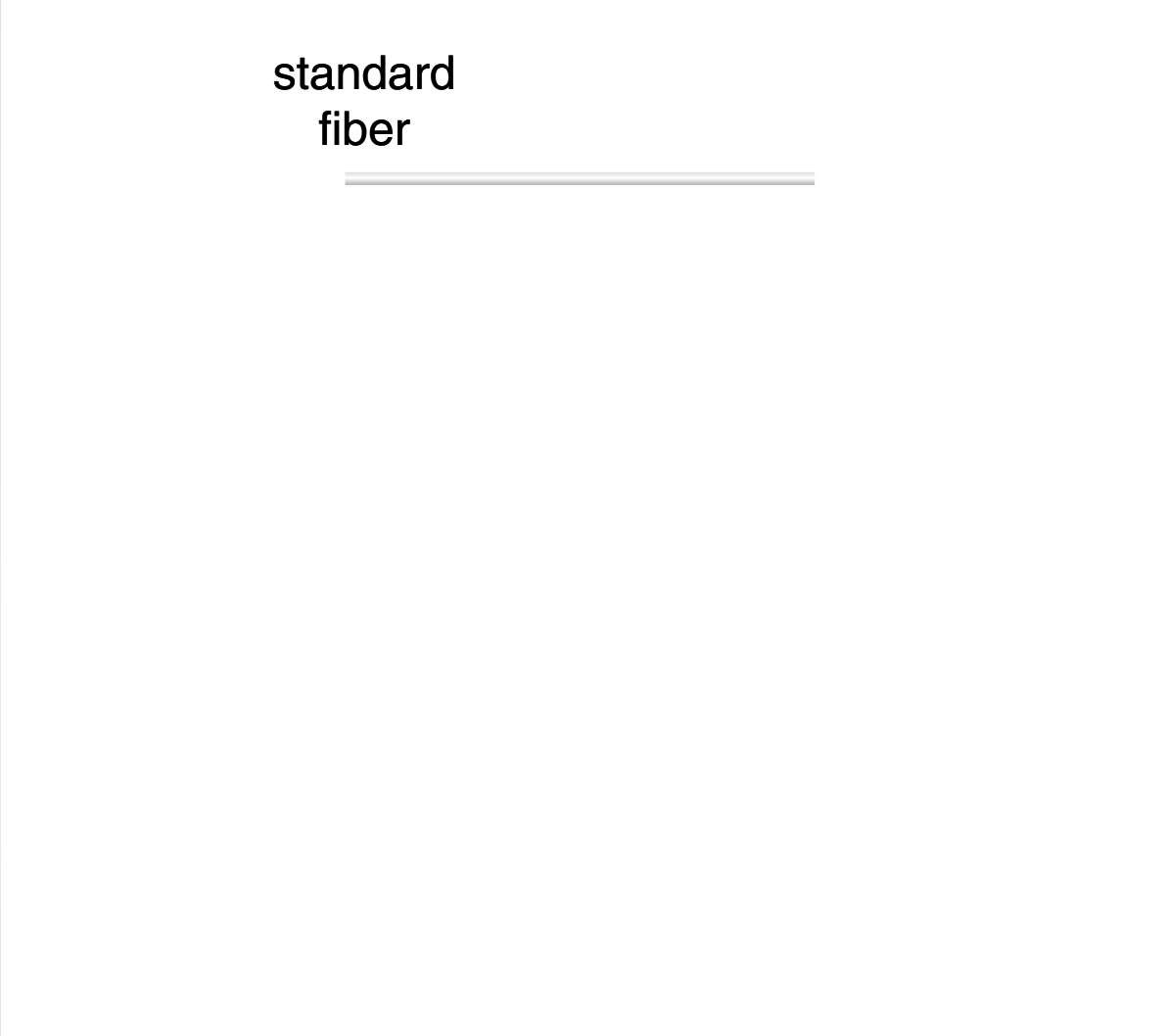
- nanowire fabrication
- optical properties
- supercontinuum spectra

Nanowire fabrication



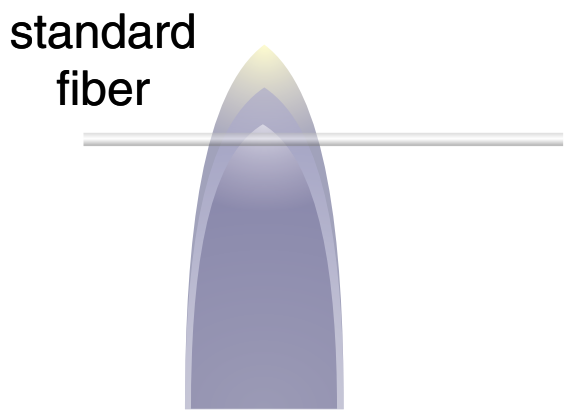
Nanowire fabrication

two-step drawing process



Nanowire fabrication

two-step drawing process



Nanowire fabrication

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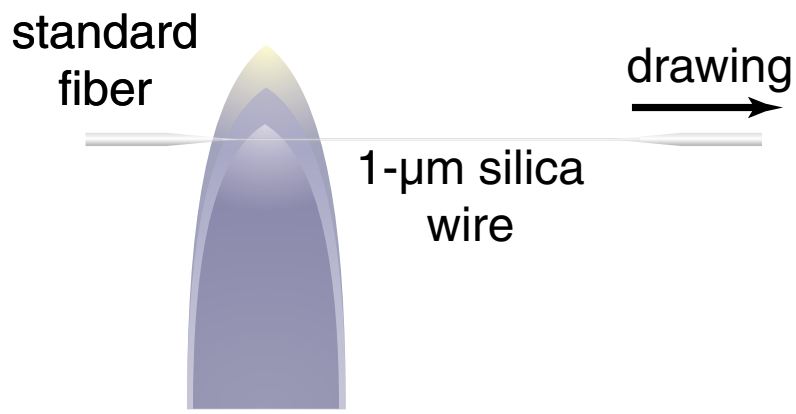
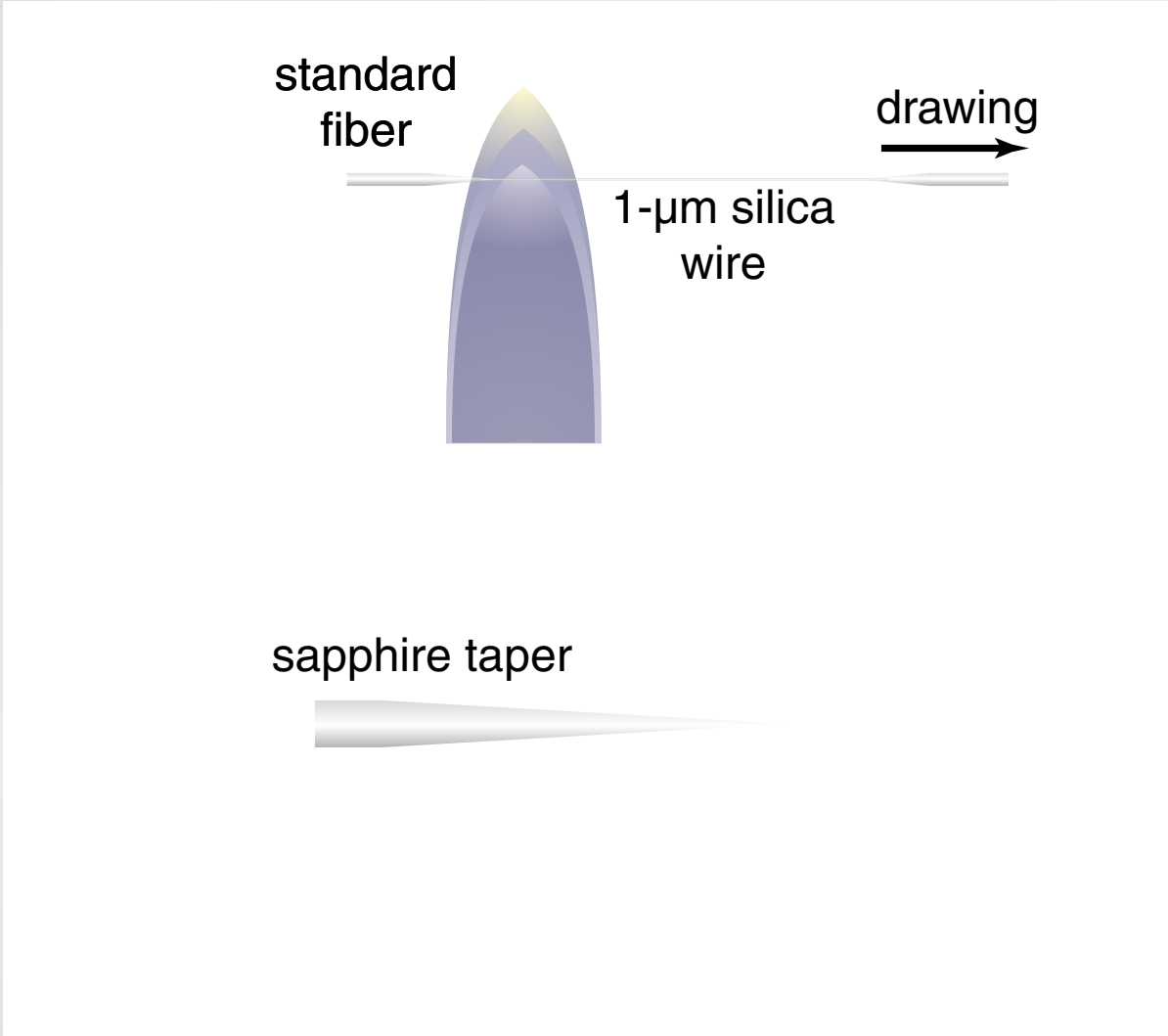


Nanowire fabrication

two-step drawing process



Nanowire fabrication

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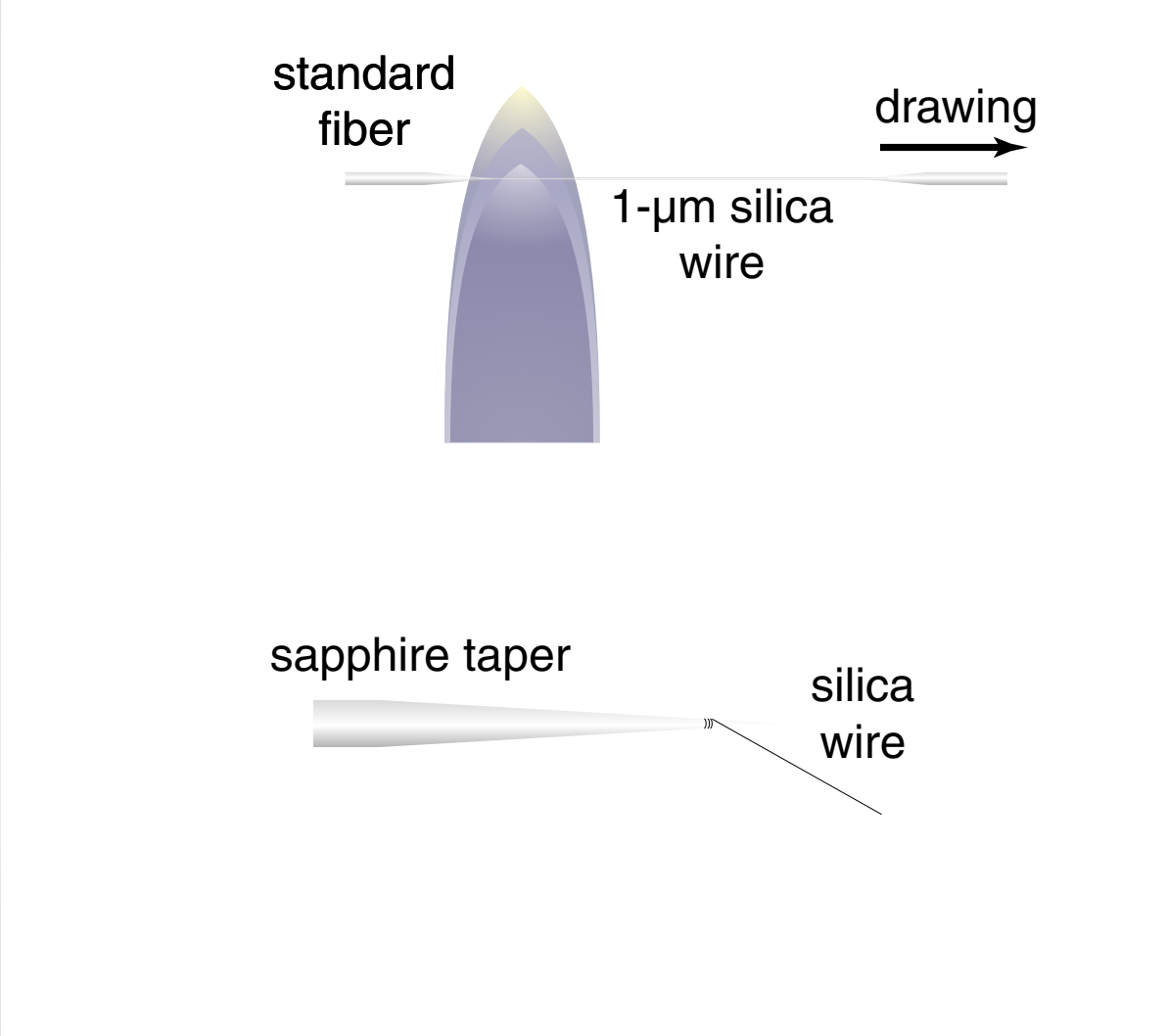

Nanowire fabrication

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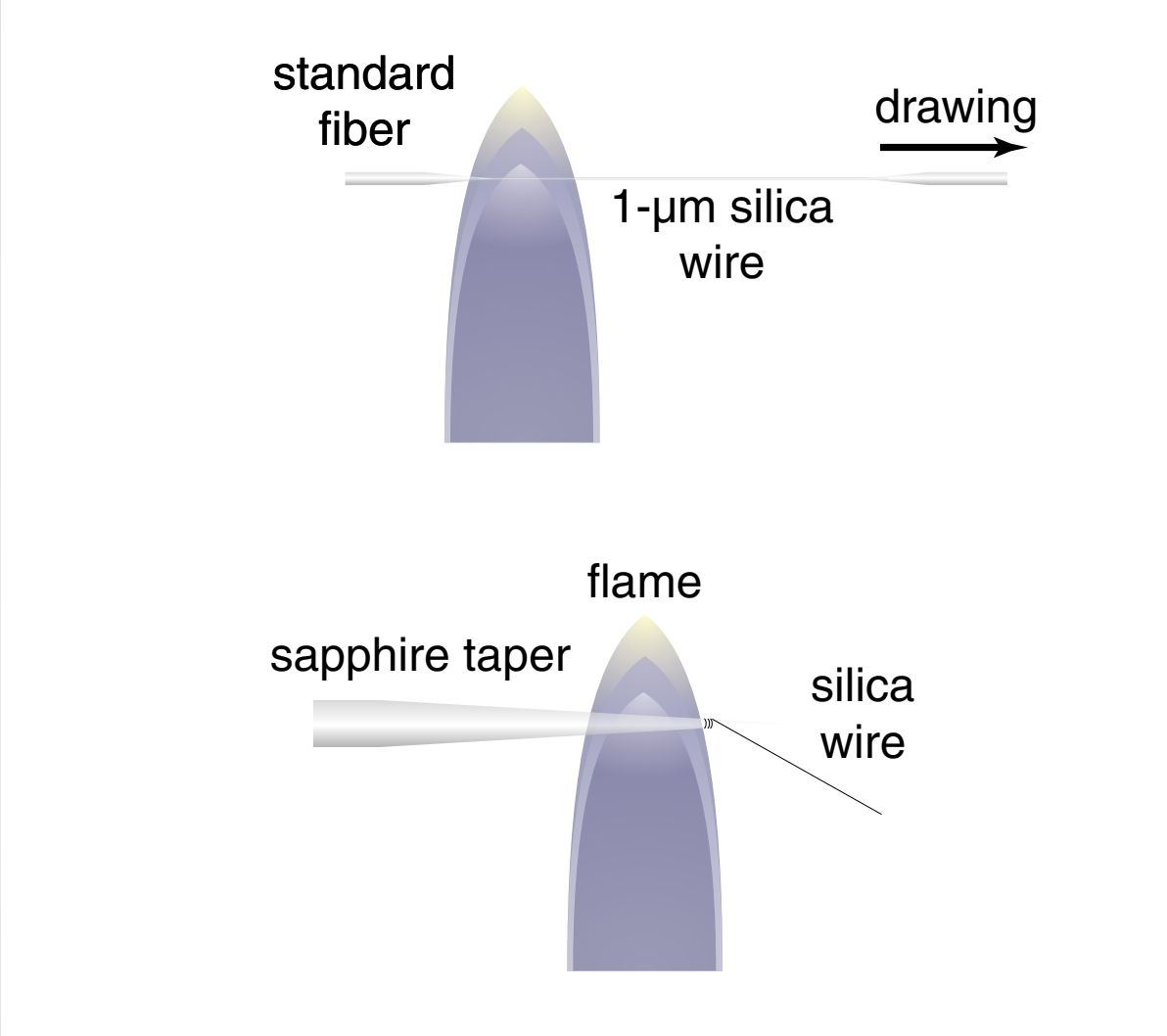
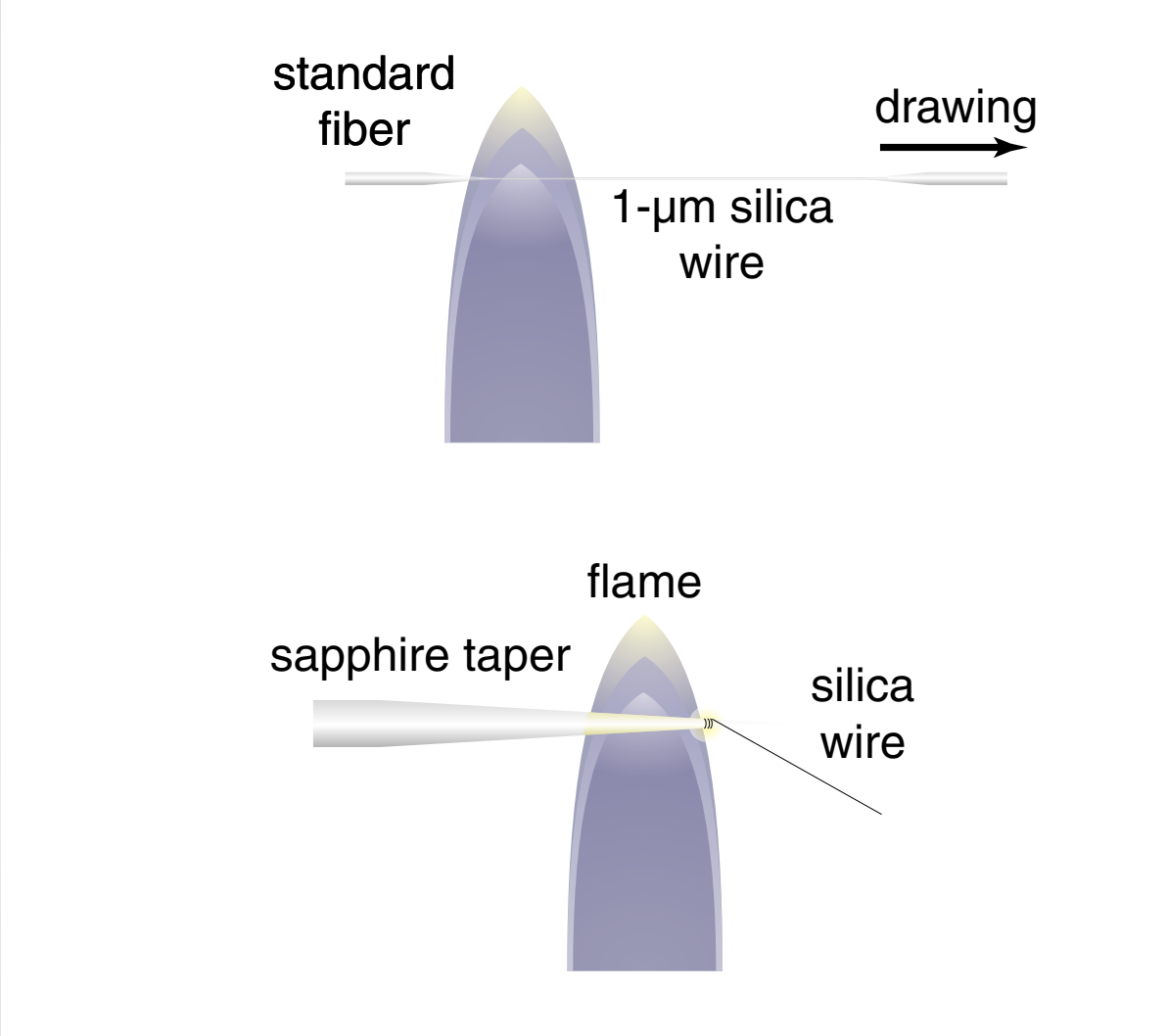


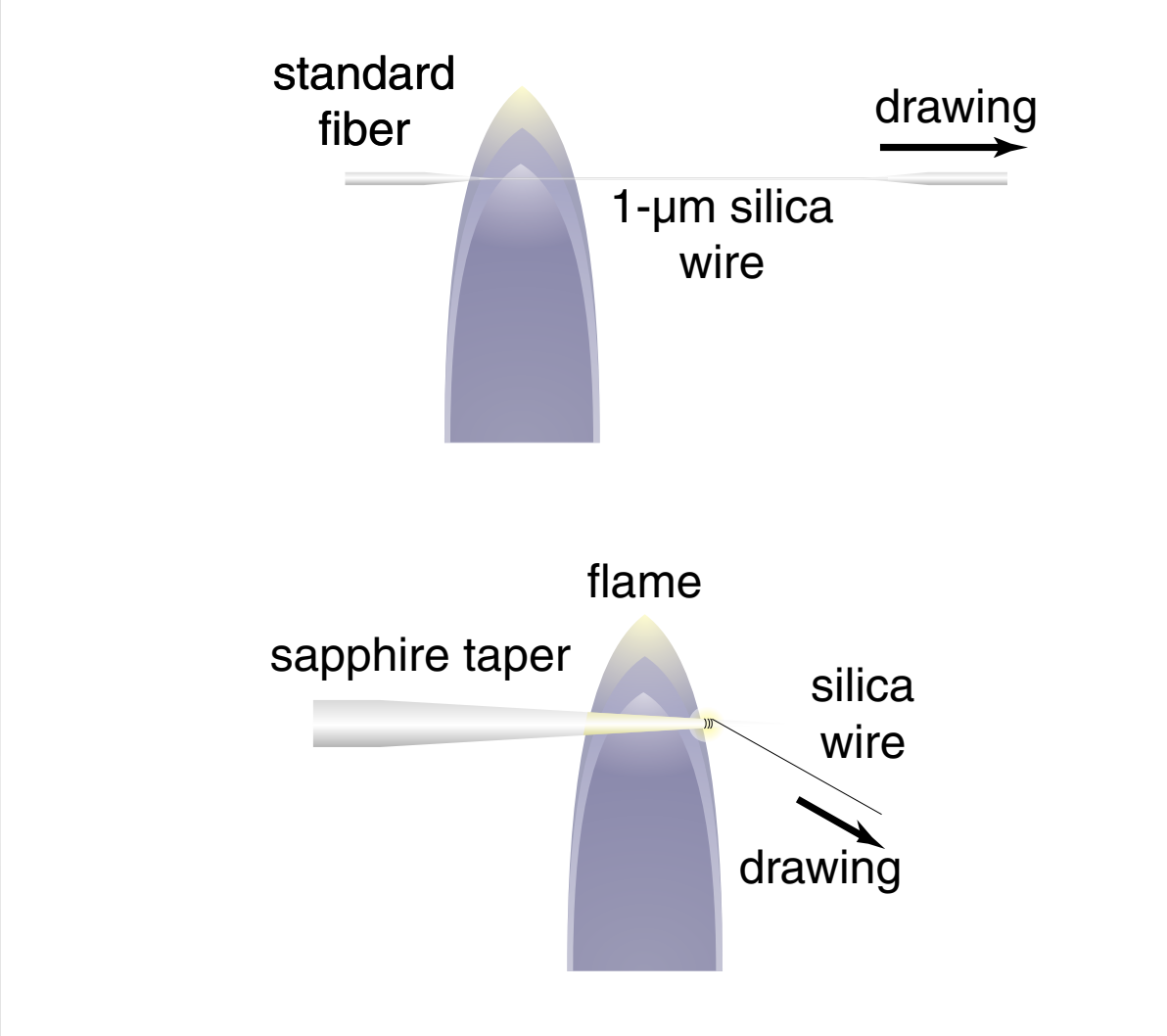
Nanowire fabrication

two-step drawing process

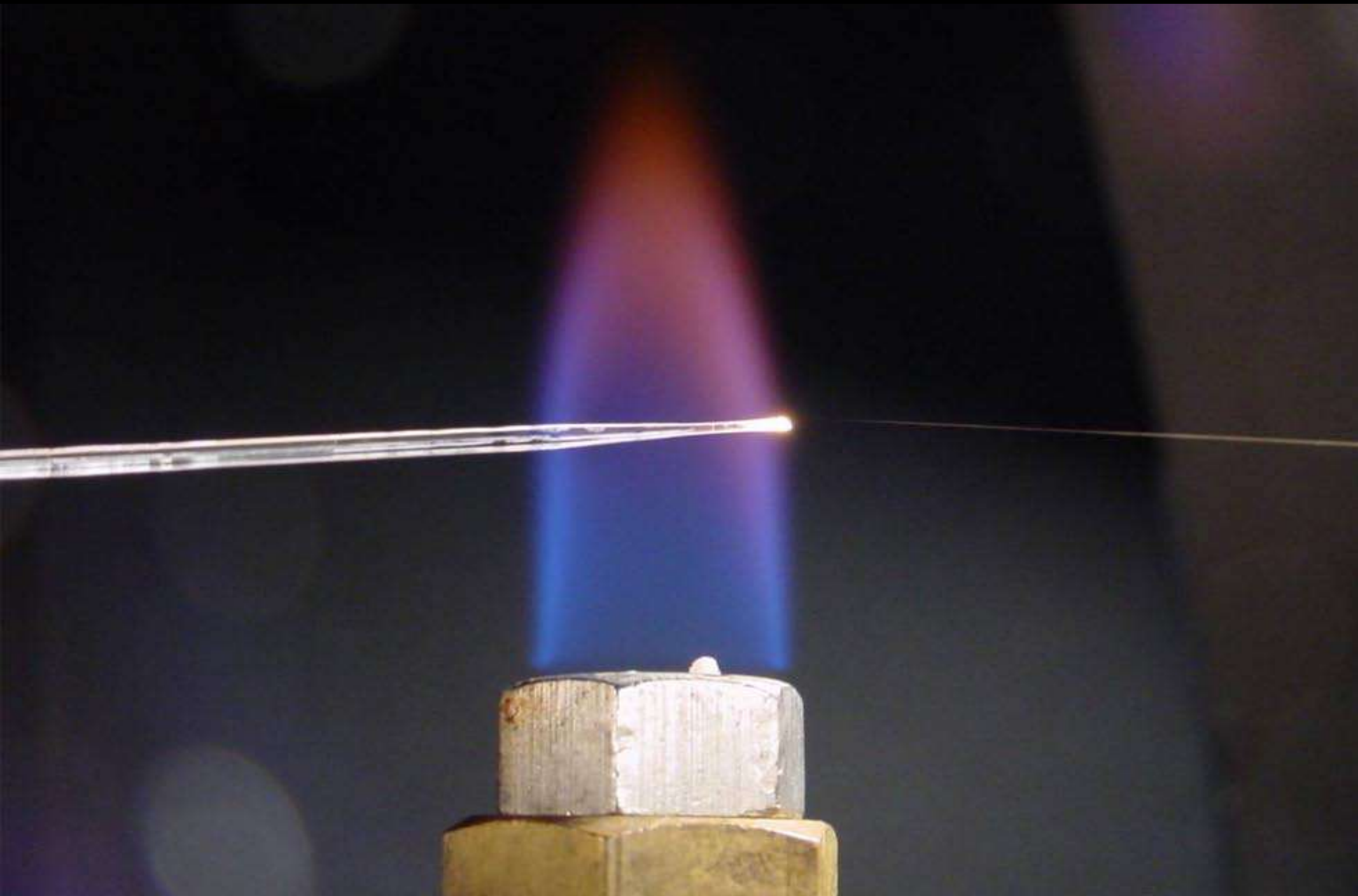


Nanowire fabrication

two-step drawing process



Nanowire fabrication



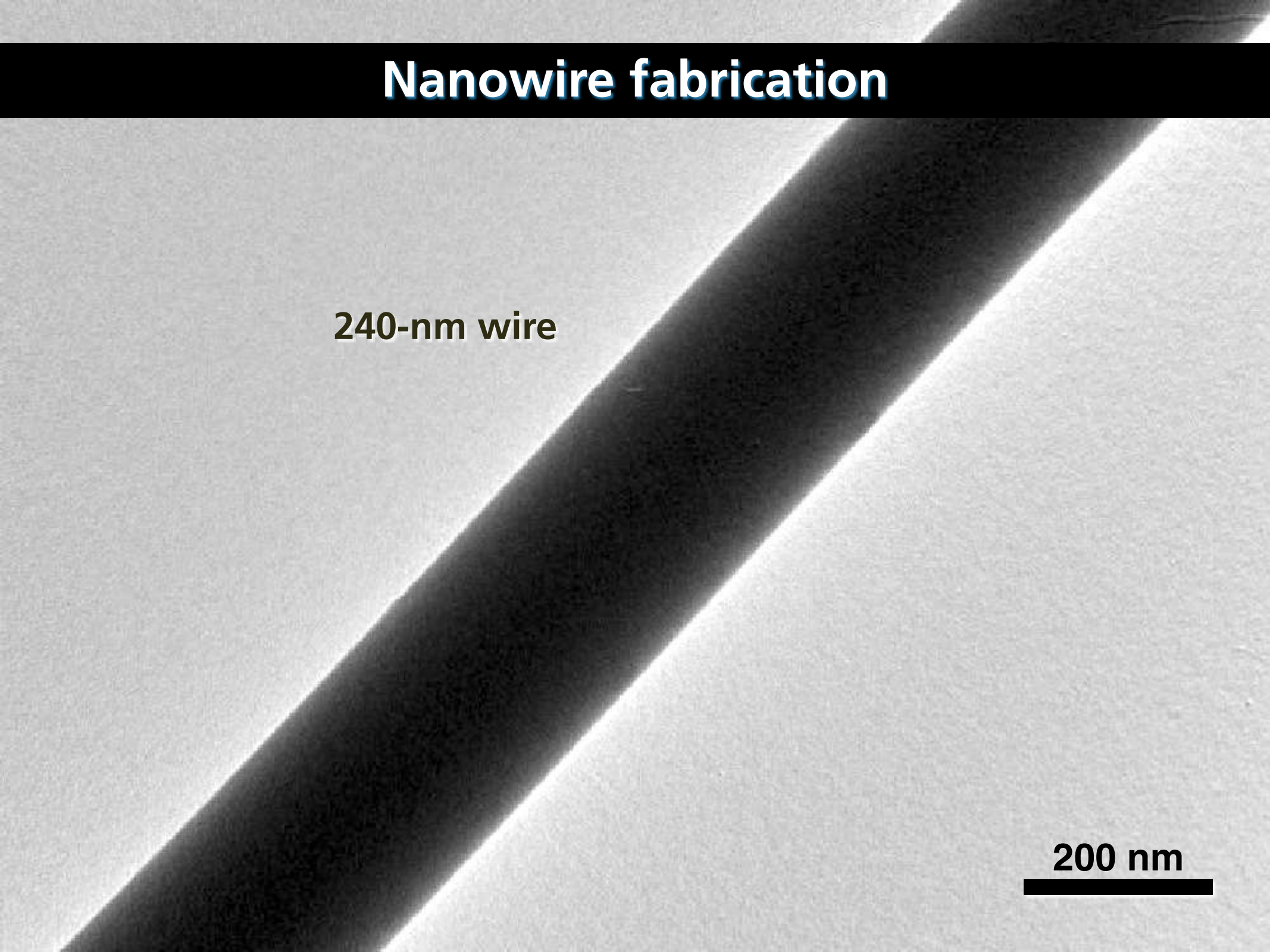
Waveguiding

Specifications

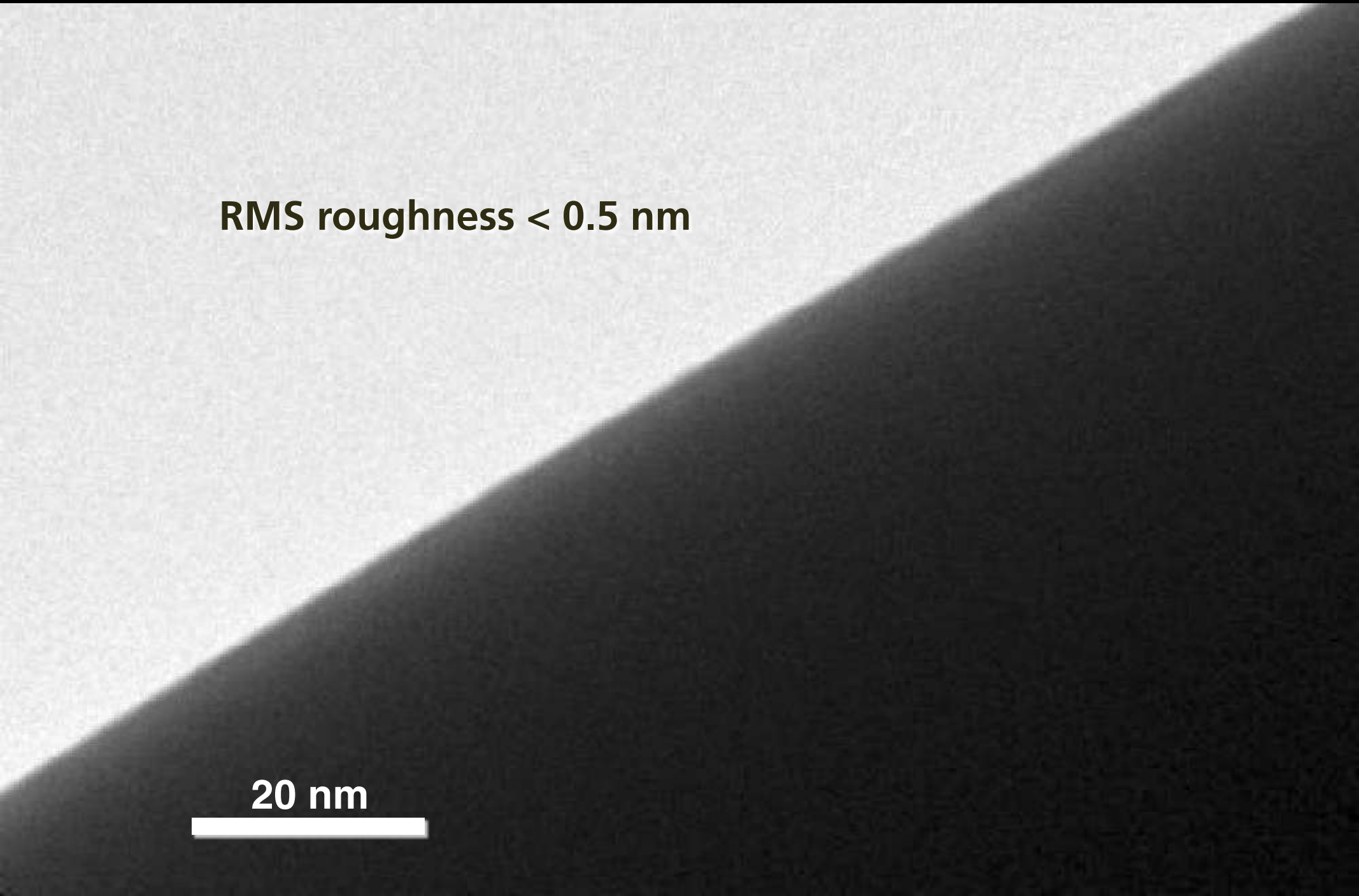
diameter D:	down to 20 nm
length L:	up to 90 mm
aspect ratio D/L:	up to 10^6
diameter uniformity $\Delta D/L$:	2×10^{-6}

Nature, 426, 816 (2003)

Nanowire fabrication



Nanowire fabrication

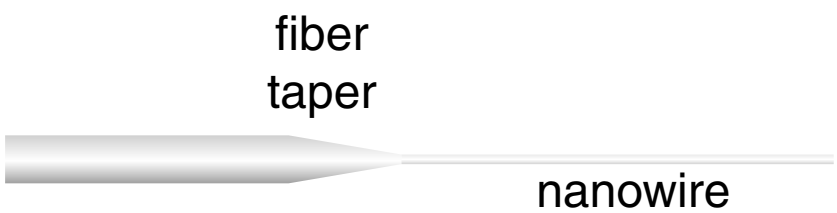


Outline

- nanowire fabrication
- optical properties
- supercontinuum spectra

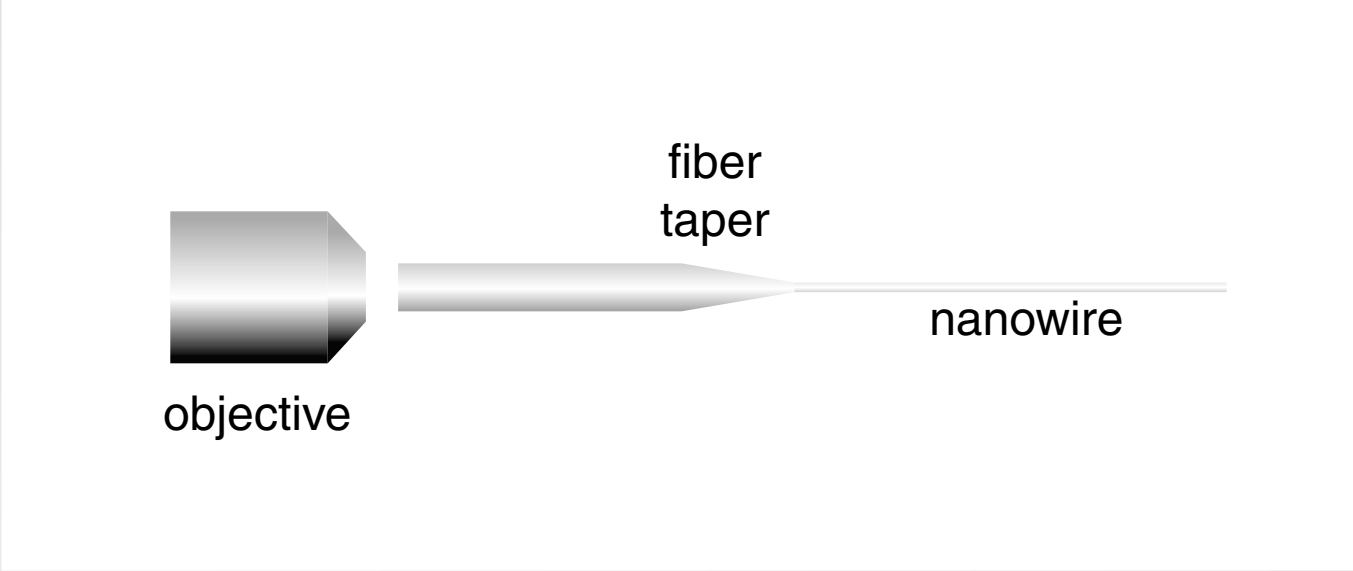
Optical properties

coupling light into nanowires



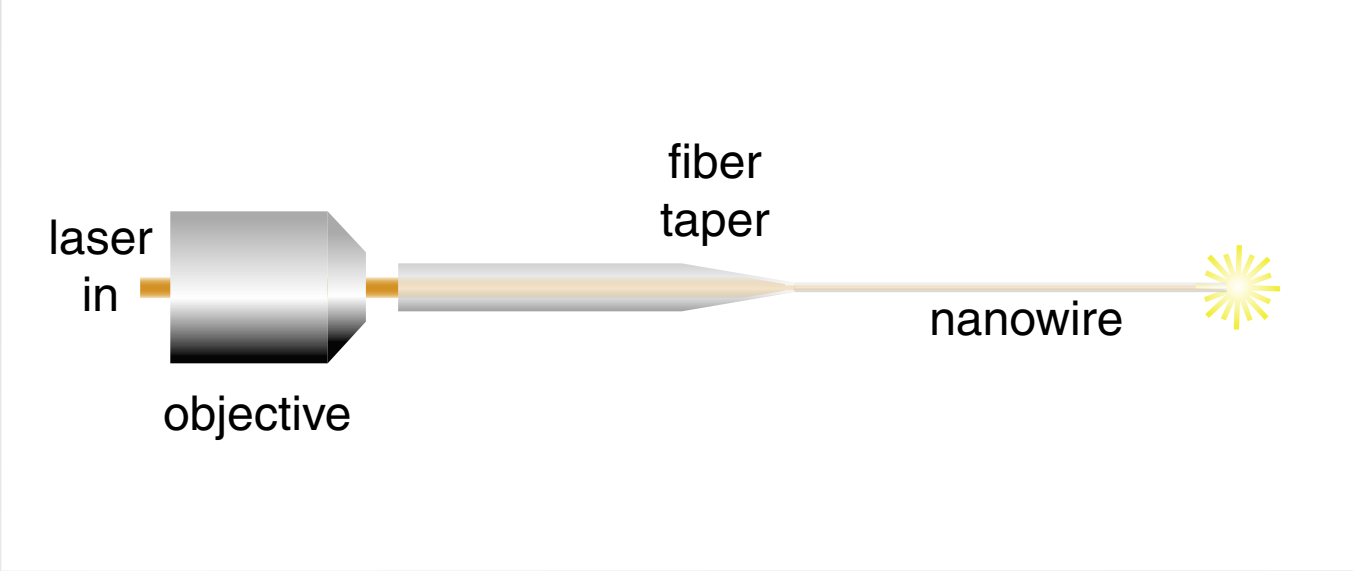
Optical properties

coupling light into nanowires



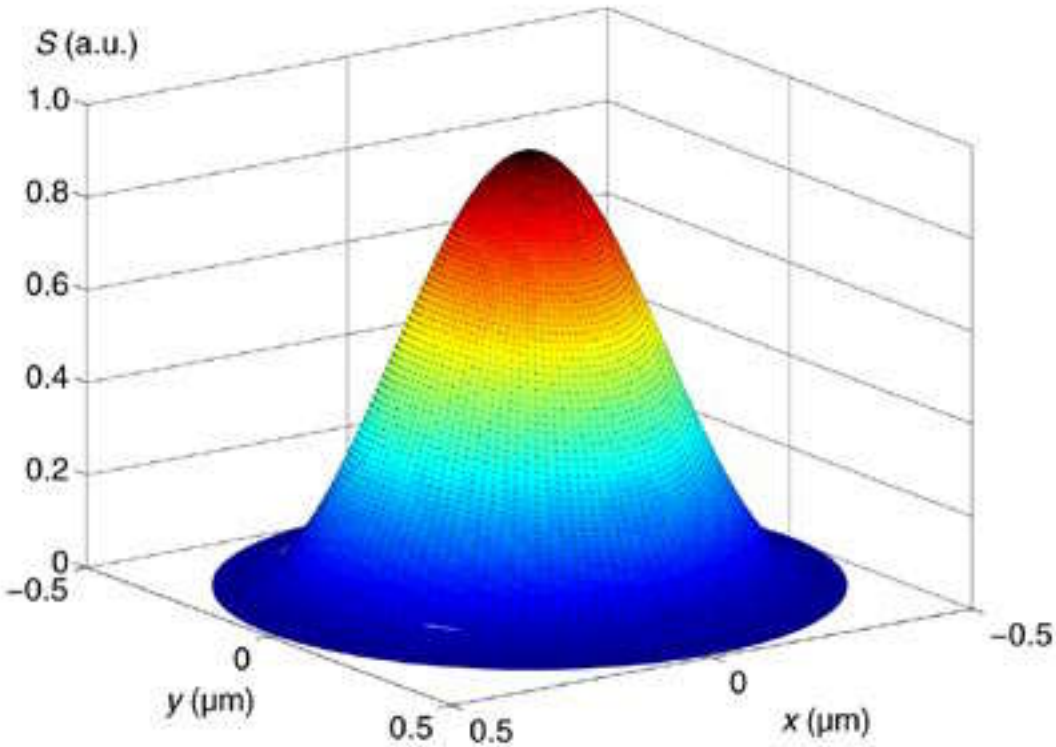
Optical properties

coupling light into nanowires



Optical properties

Poynting vector profile for 800-nm nanowire



Optical properties

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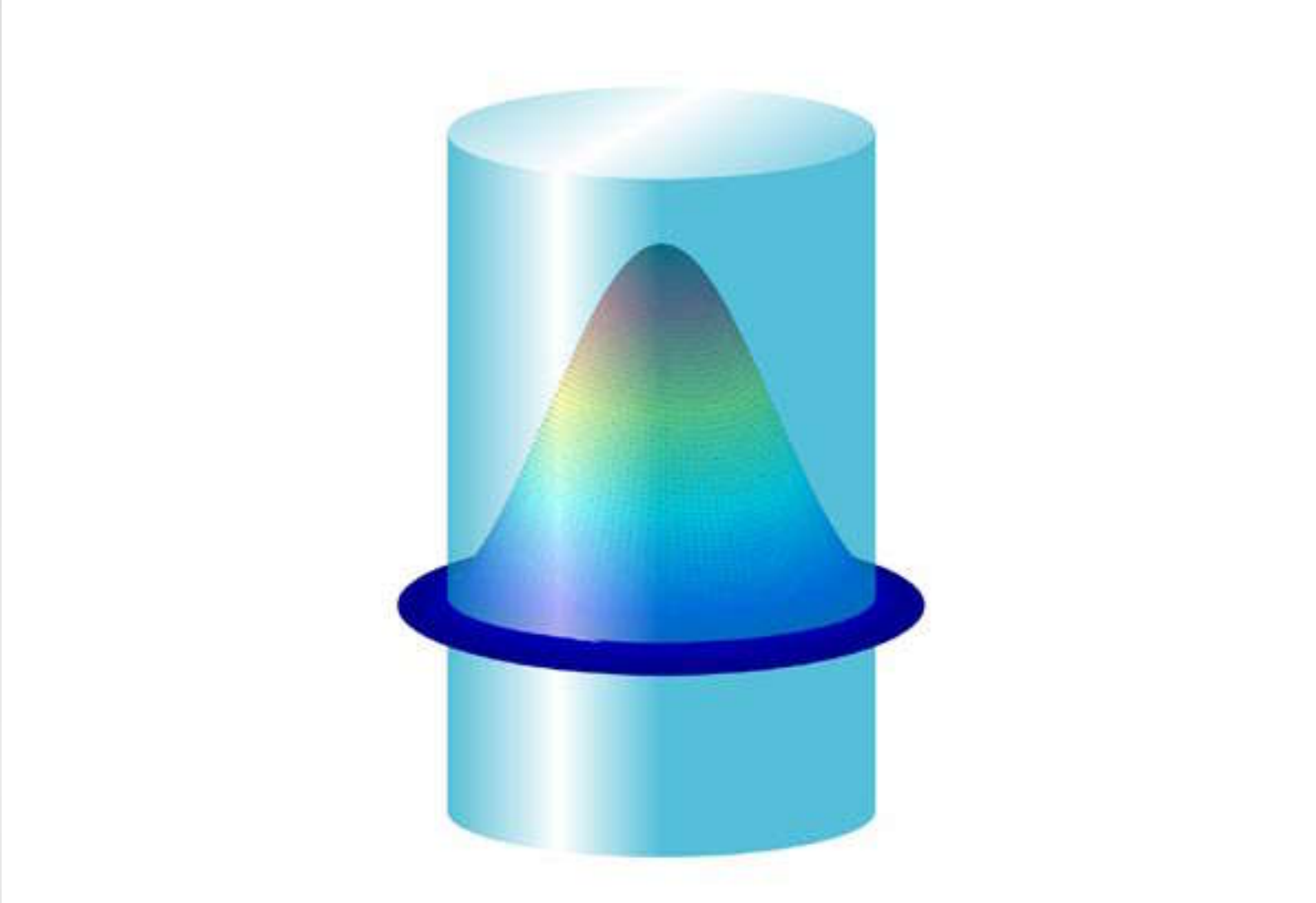
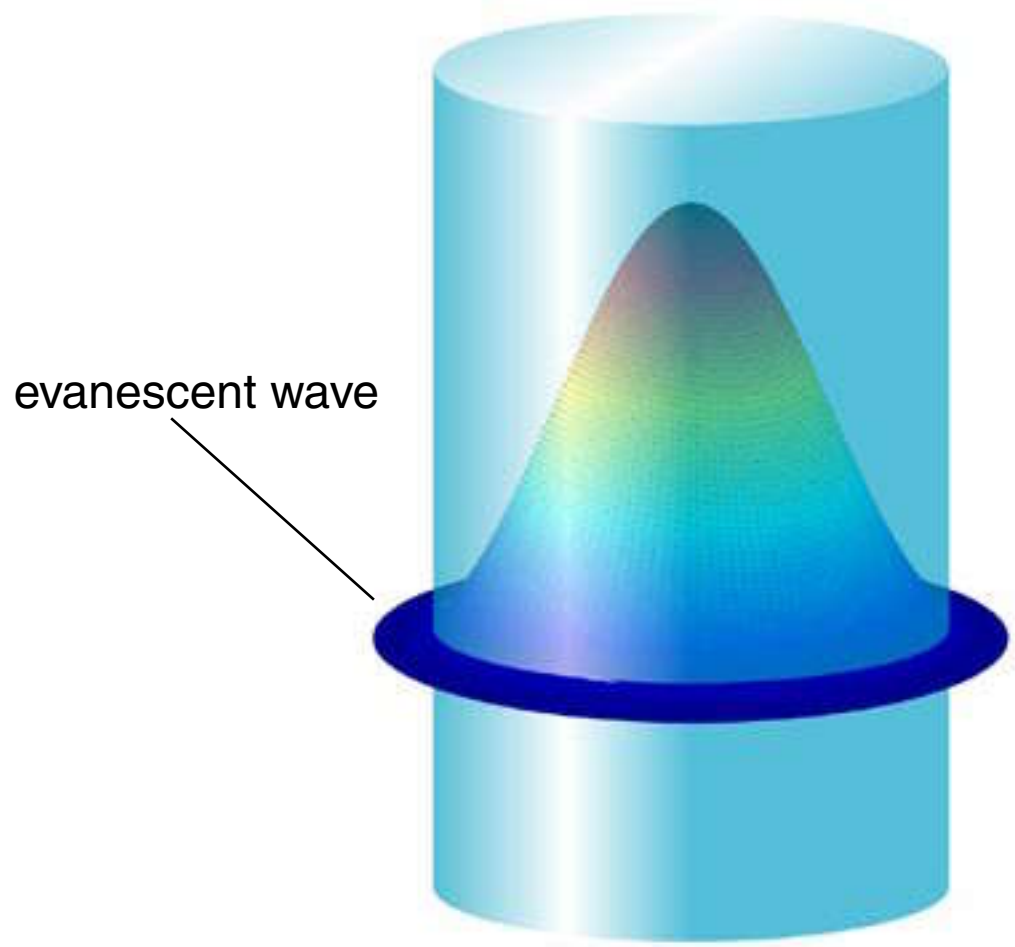


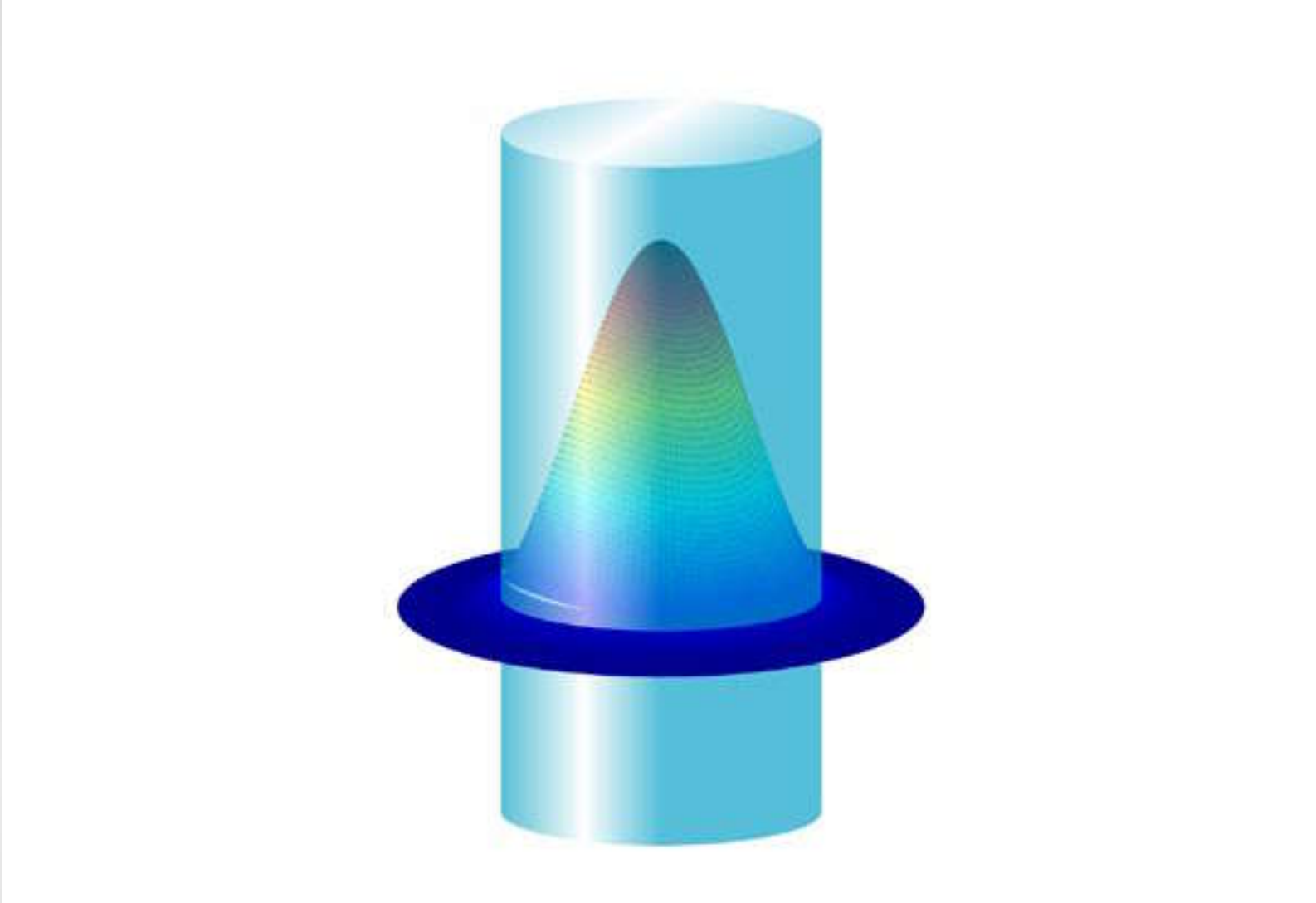
Optical properties

Poynting vector profile for 800-nm nanowire



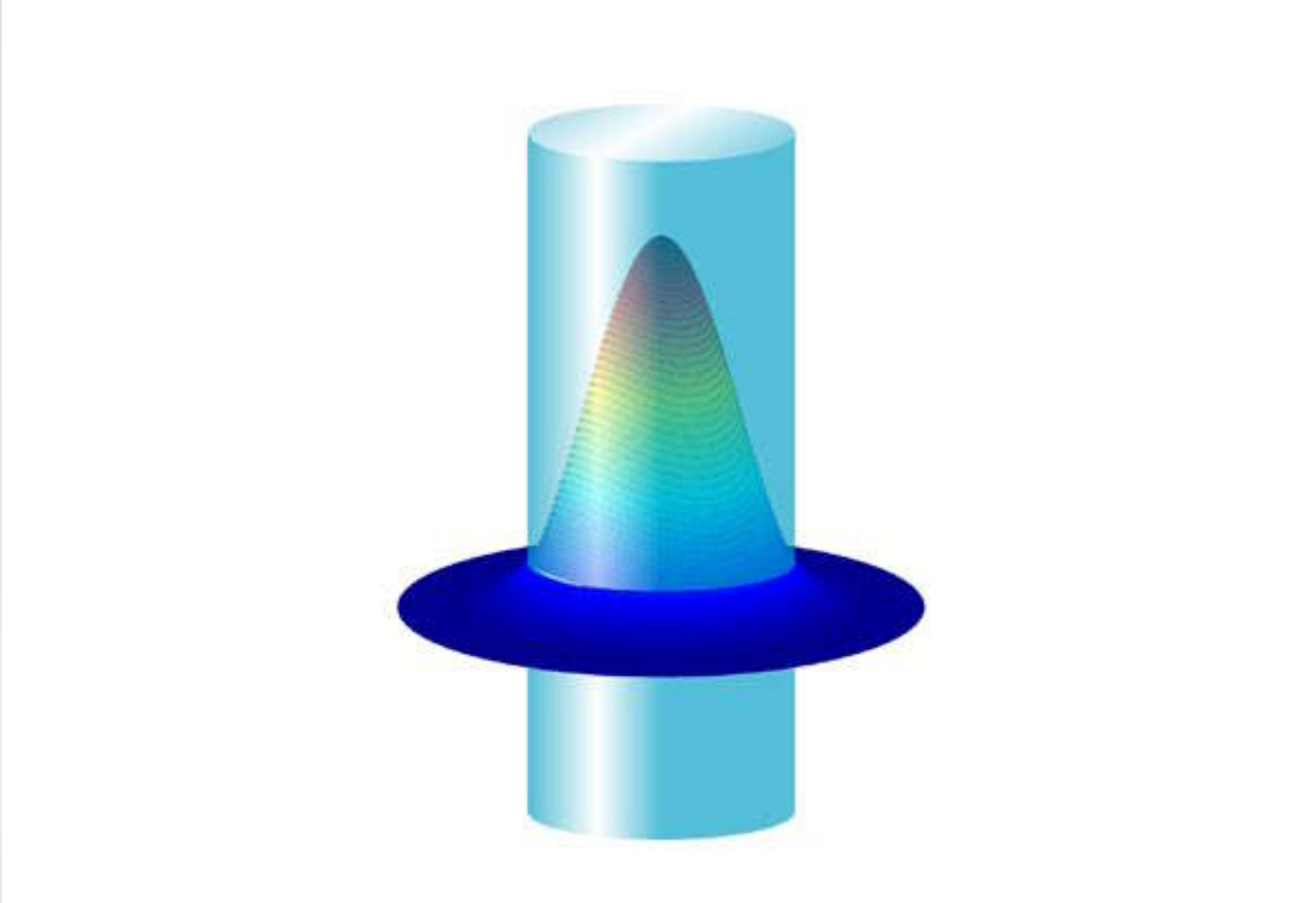
Optical properties

Poynting vector profile for 600-nm nanowire



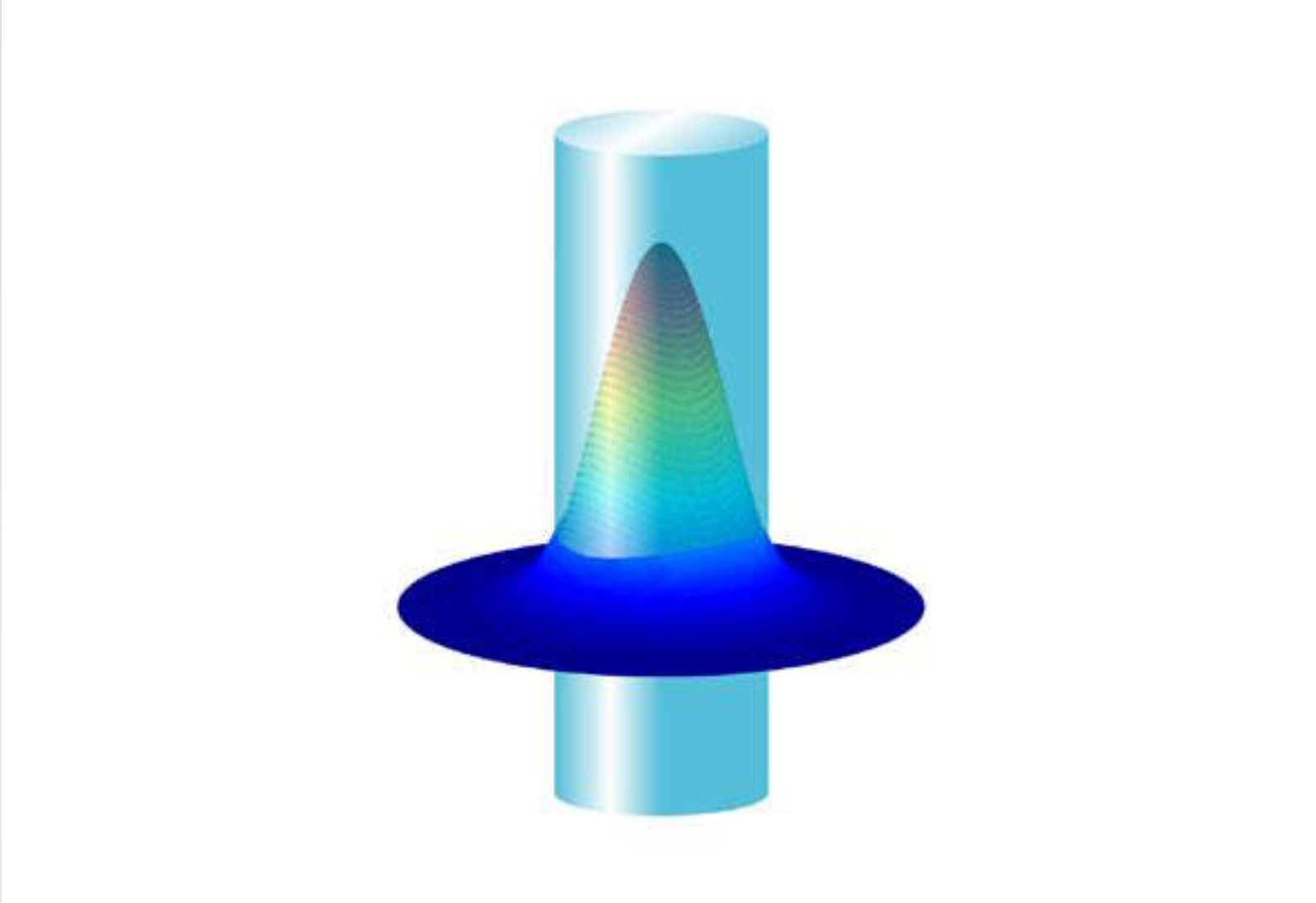
Optical properties

Poynting vector profile for 500-nm nanowire



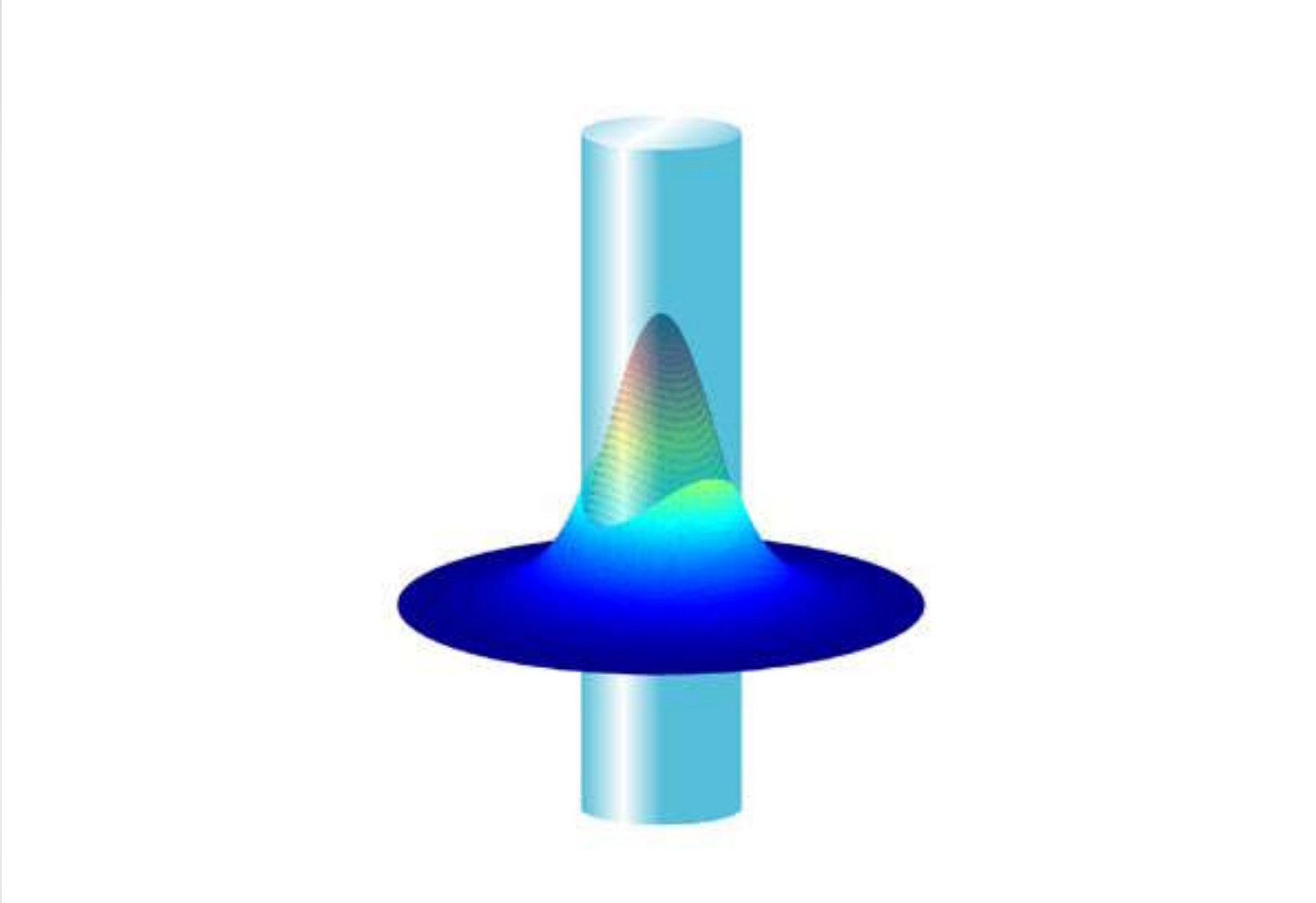
Optical properties

Poynting vector profile for 400-nm nanowire



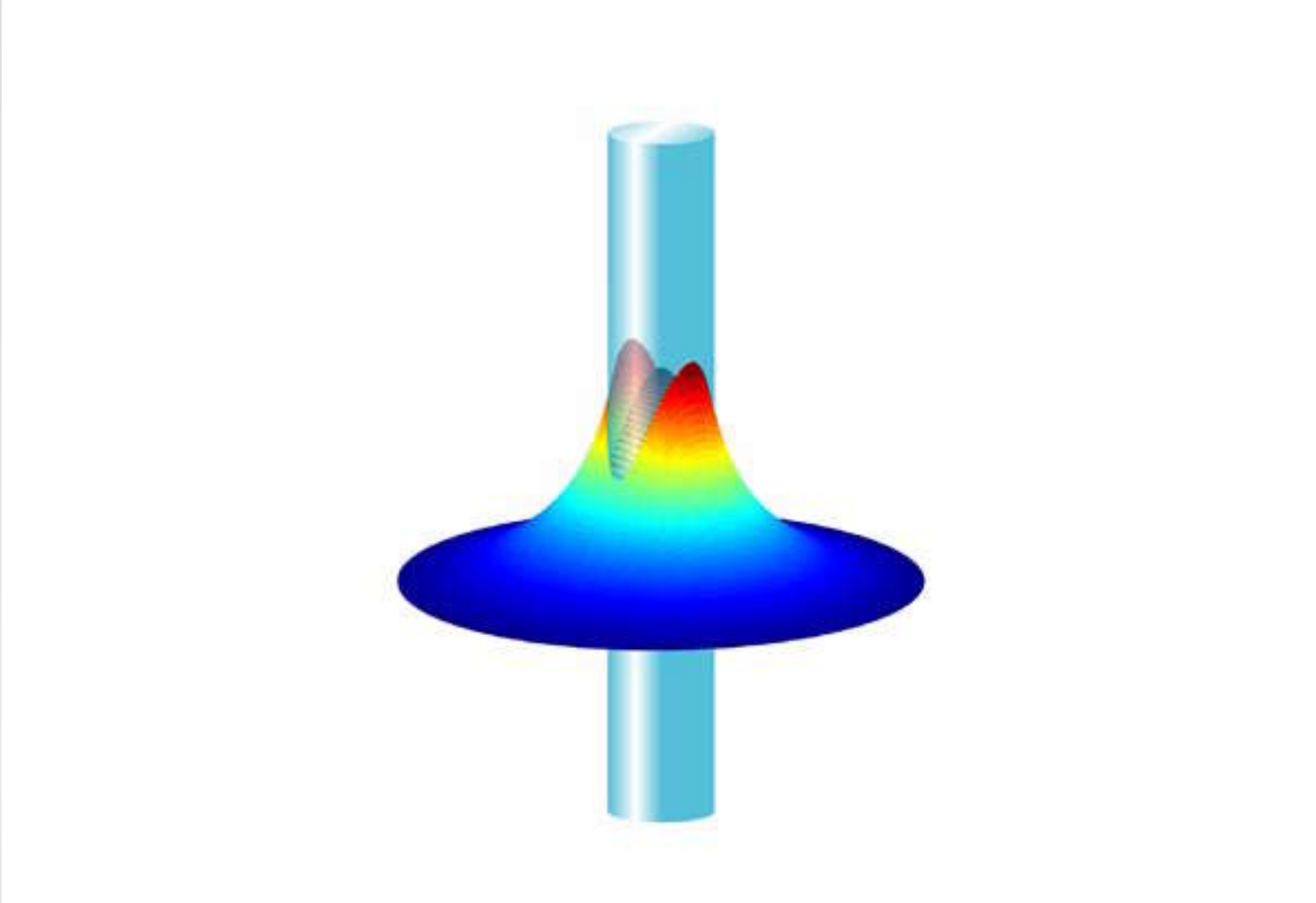
Optical properties

Poynting vector profile for 300-nm nanowire



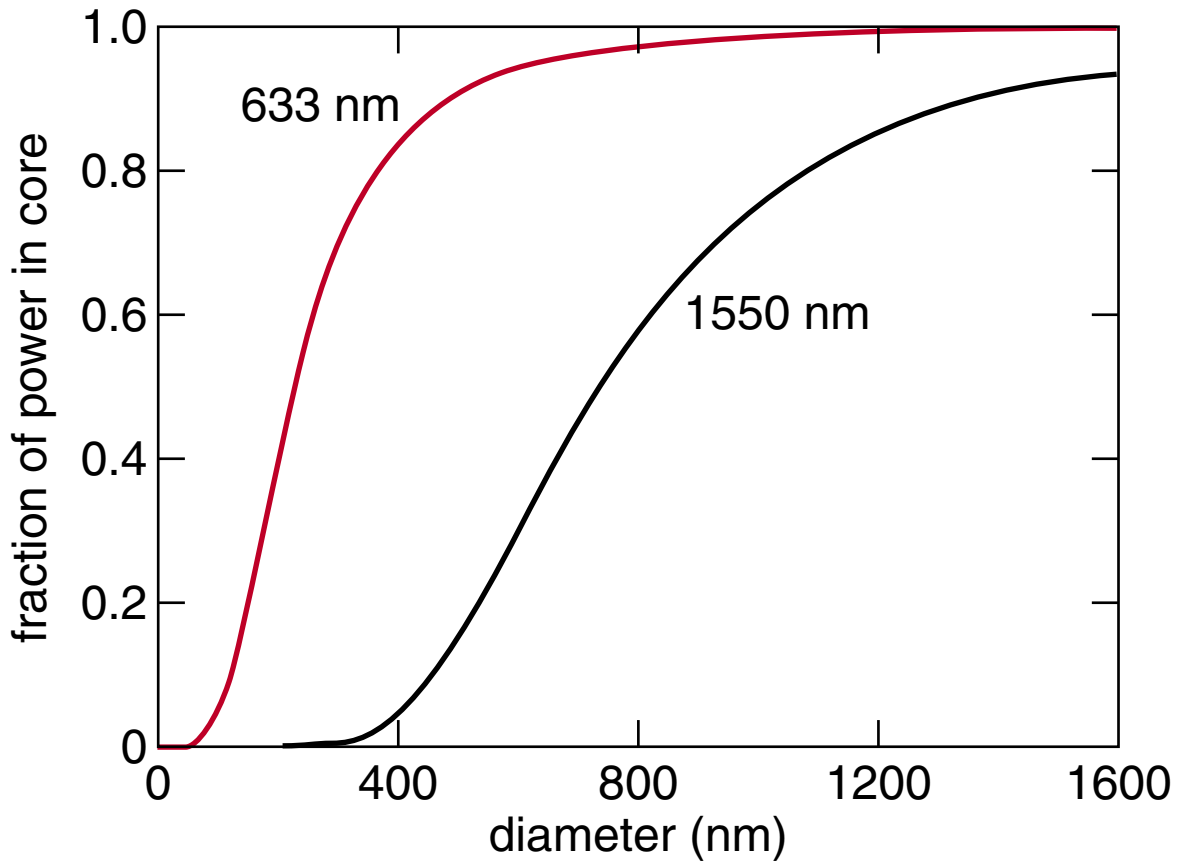
Optical properties

Poynting vector profile for 200-nm nanowire



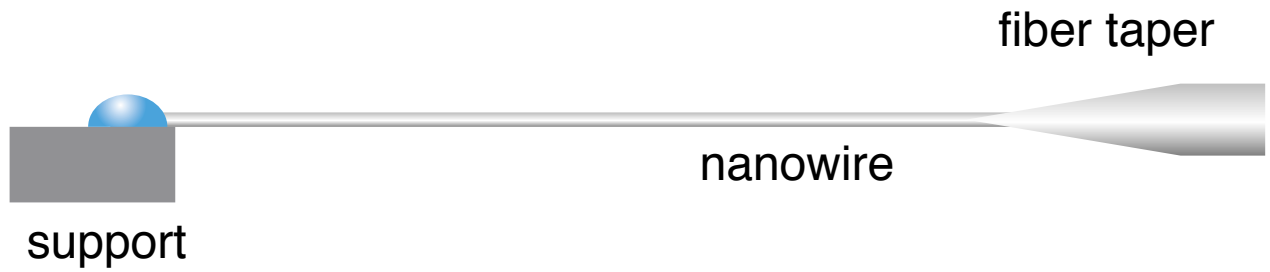
Waveguiding

fraction of power carried in core



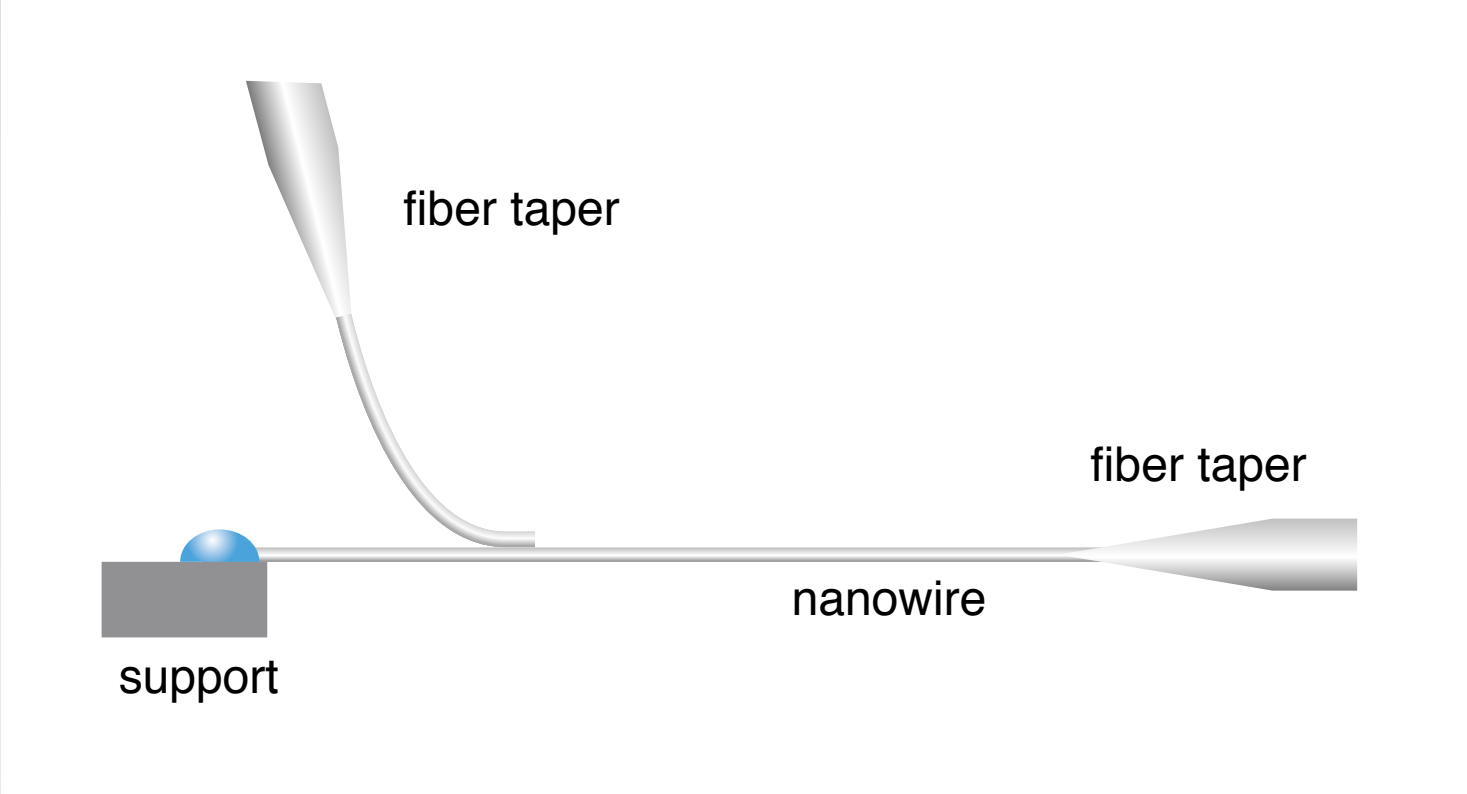
Optical properties

coupling light between nanowires



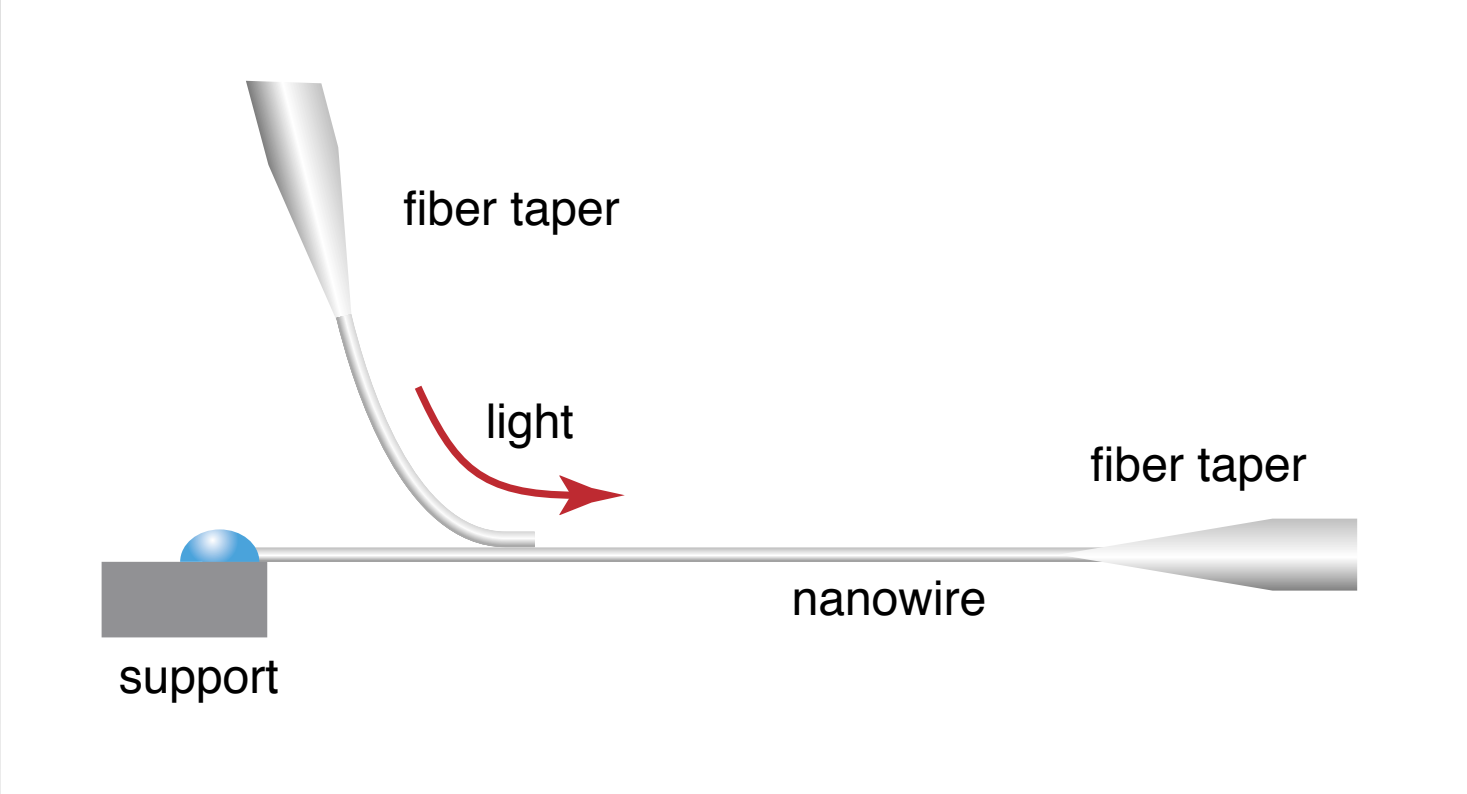
Optical properties

coupling light between nanowires



Optical properties

coupling light between nanowires



Optical properties

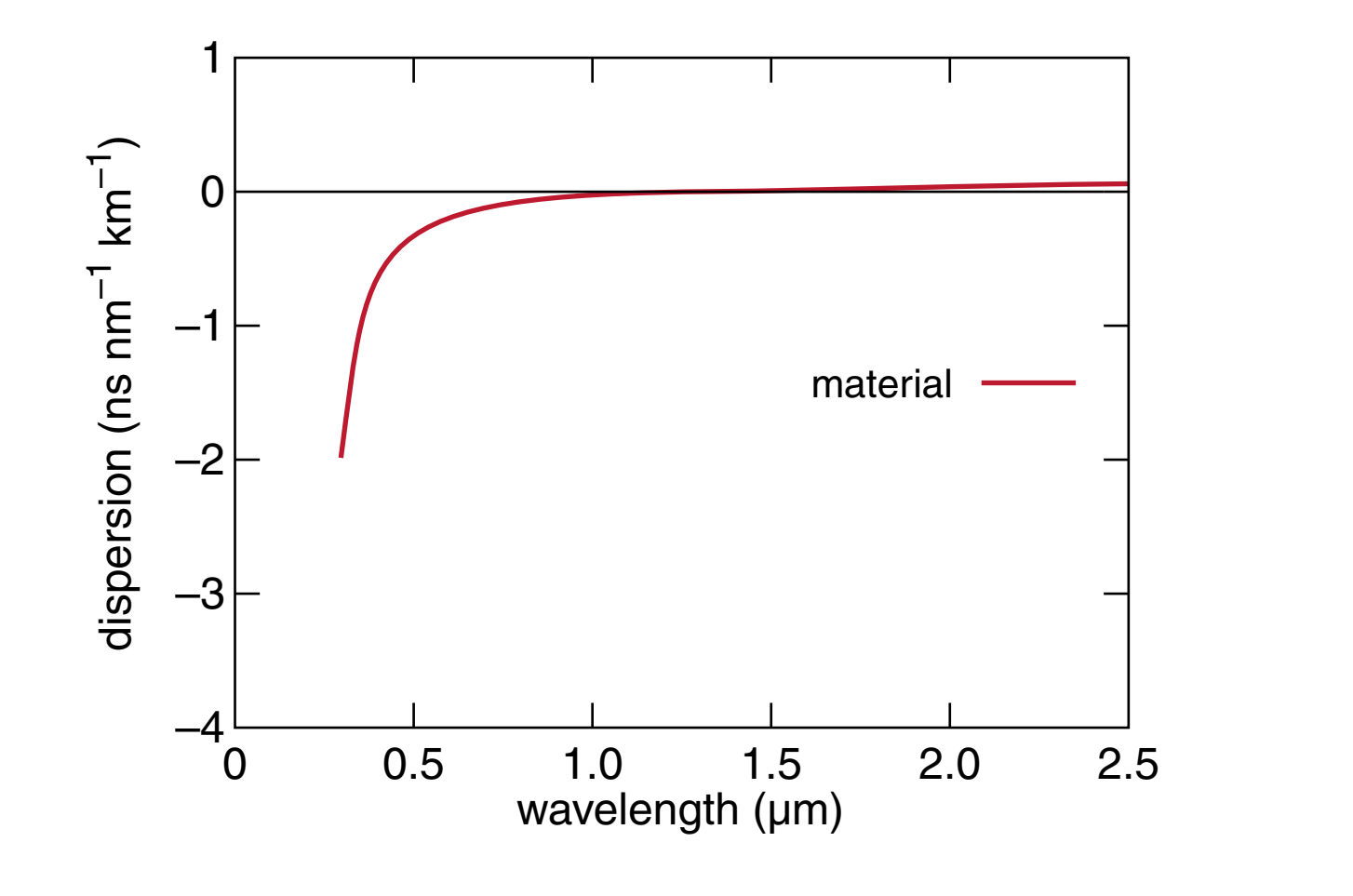
Optical properties

dispersion:

- modal dispersion
- material dispersion
- waveguide dispersion
- nonlinear dispersion

Optical properties

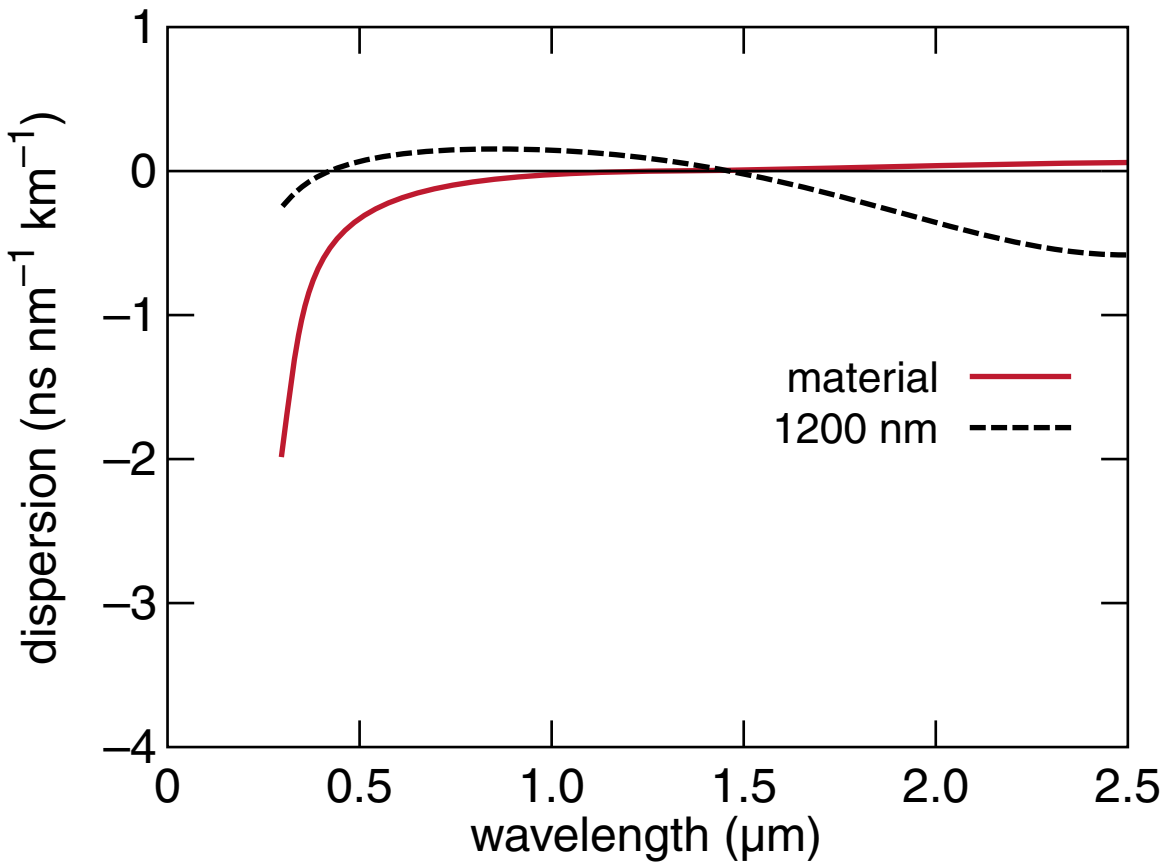
waveguide dispersion



Optics Express, 12, 1025 (2004)

Optical properties

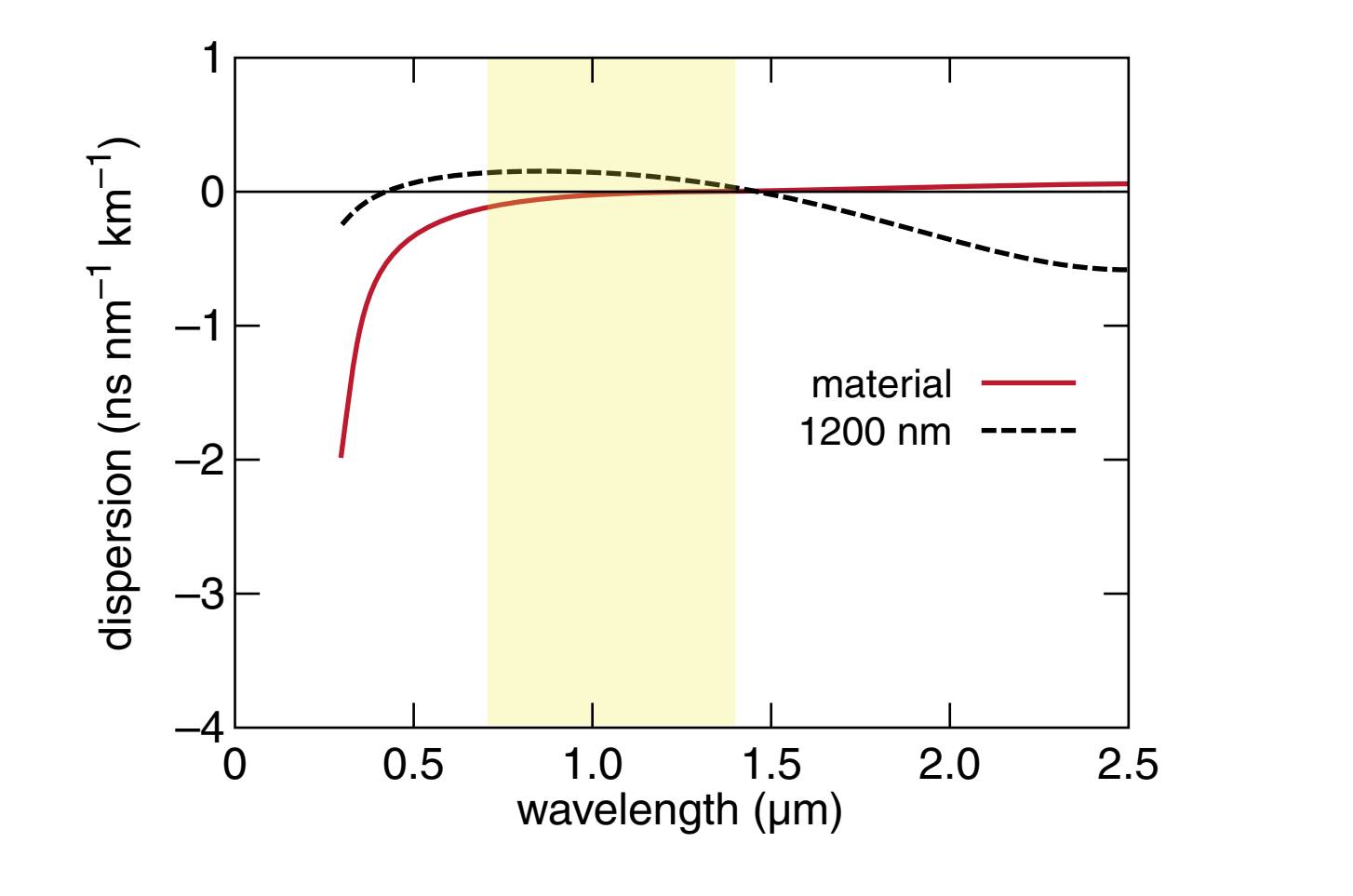
waveguide dispersion



Optics Express, 12, 1025 (2004)

Optical properties

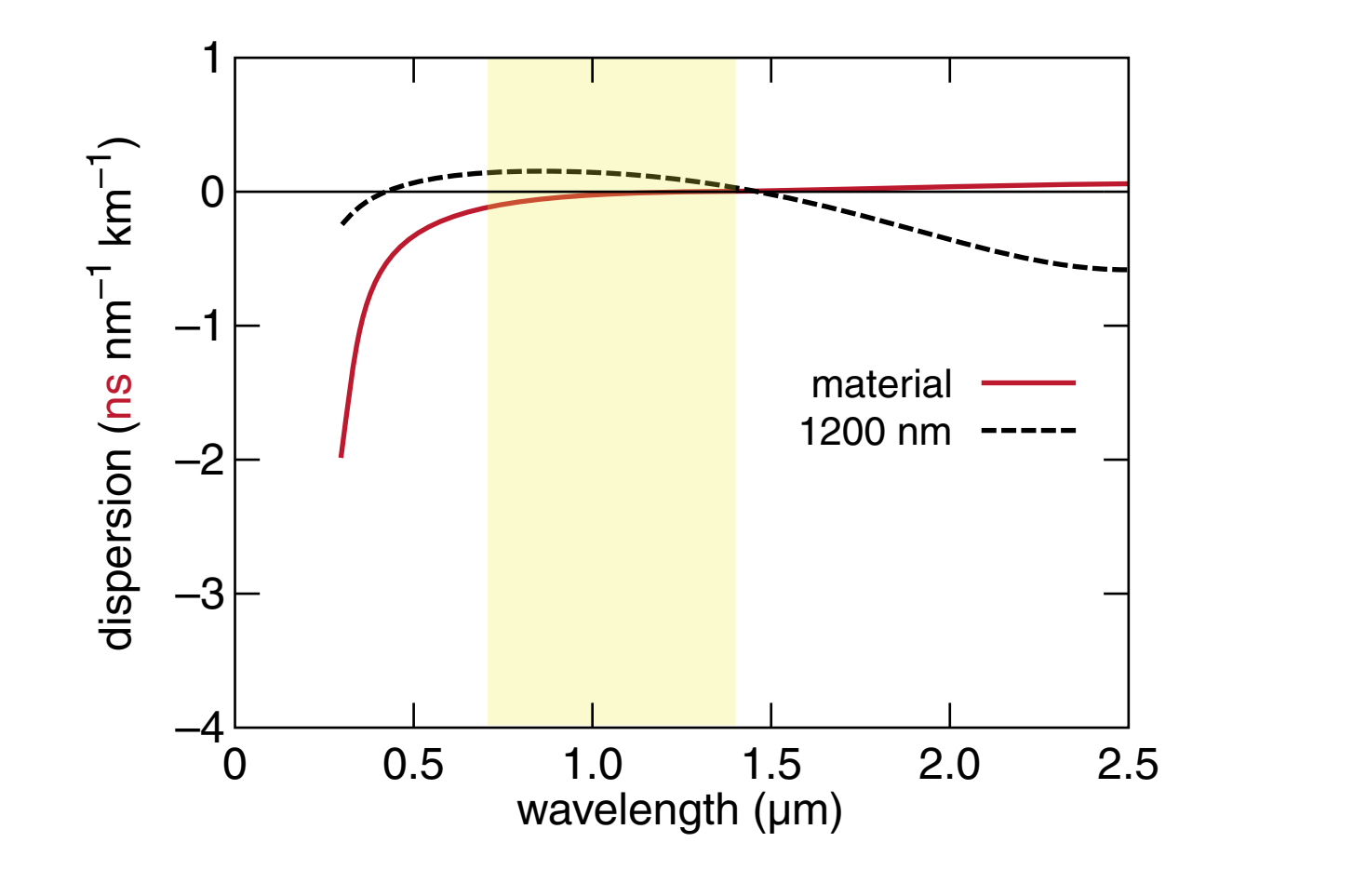
waveguide dispersion



Optics Express, 12, 1025 (2004)

Optical properties

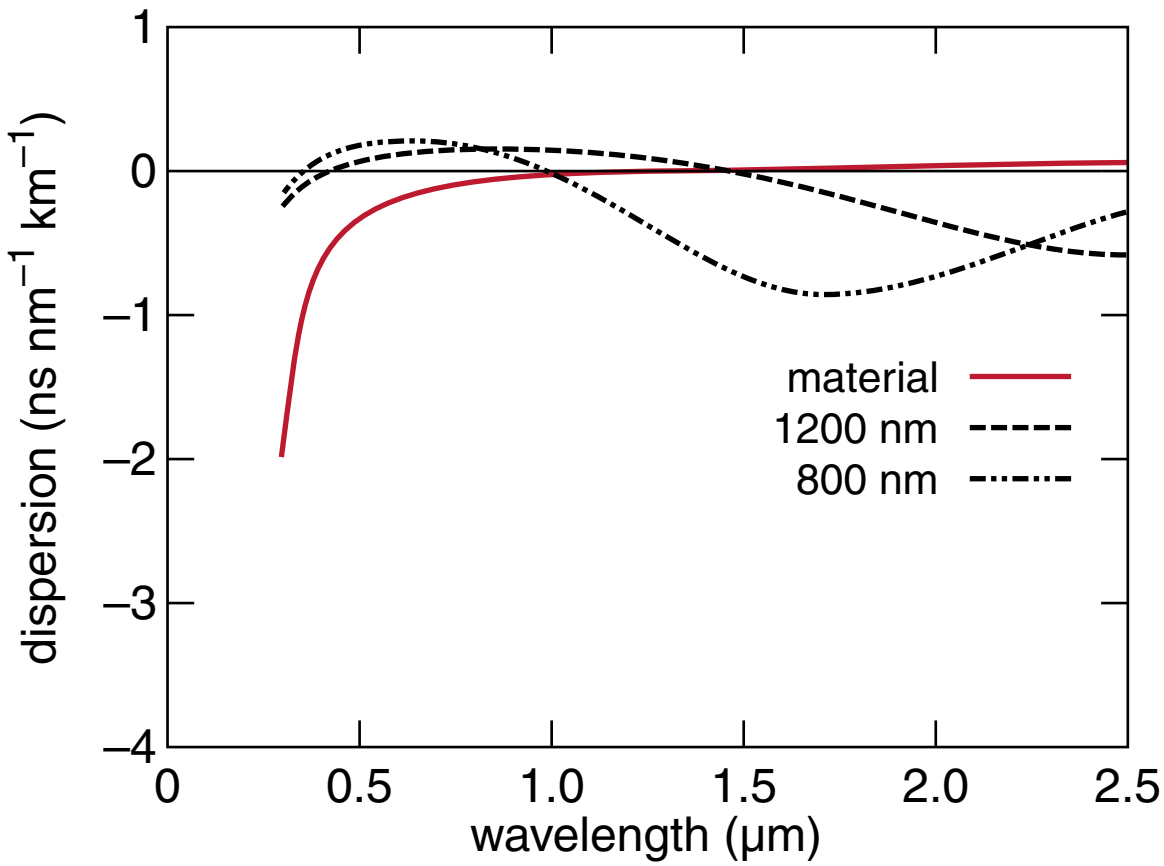
waveguide dispersion



Optics Express, 12, 1025 (2004)

Optical properties

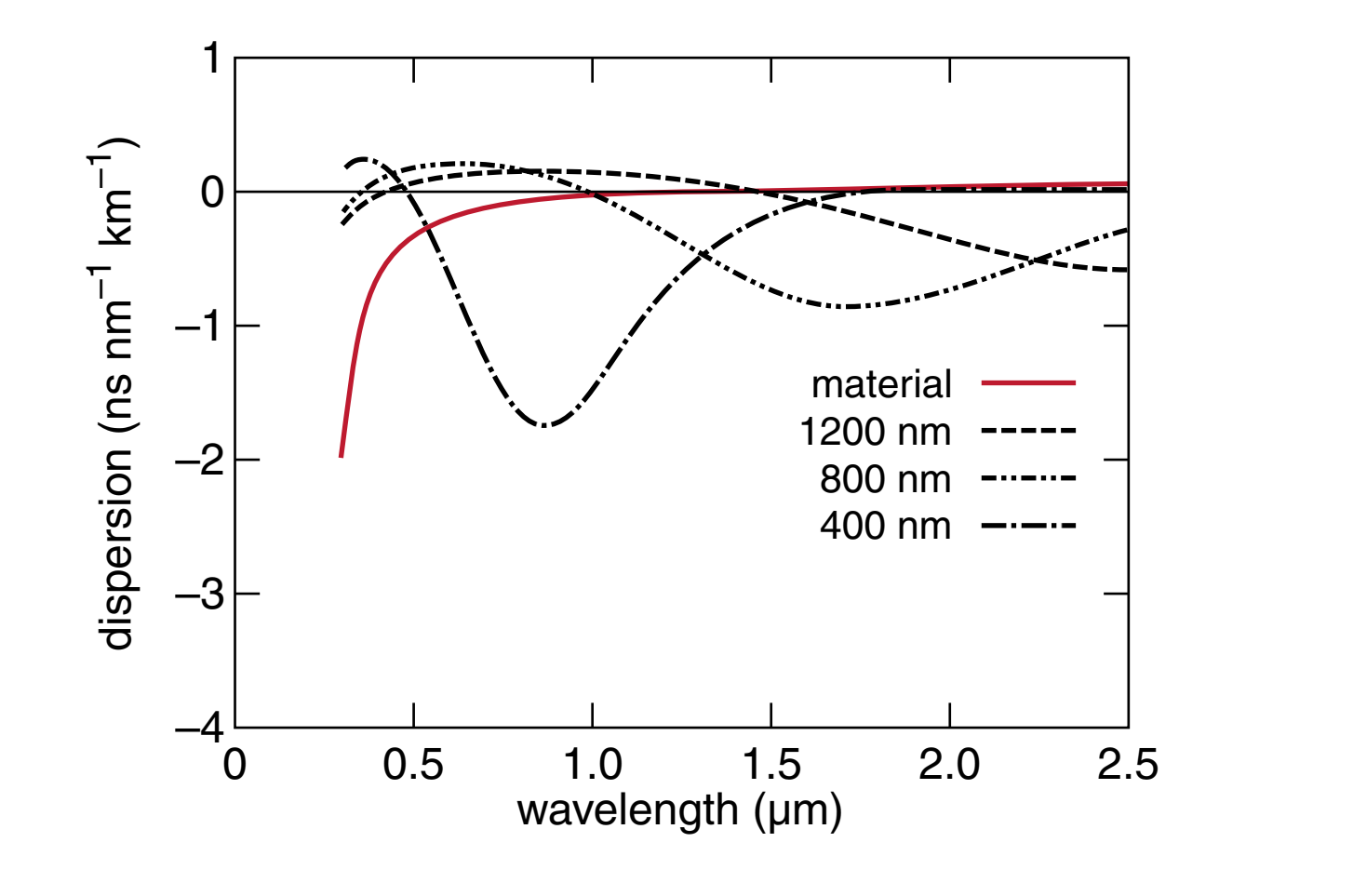
waveguide dispersion



Optics Express, 12, 1025 (2004)

Optical properties

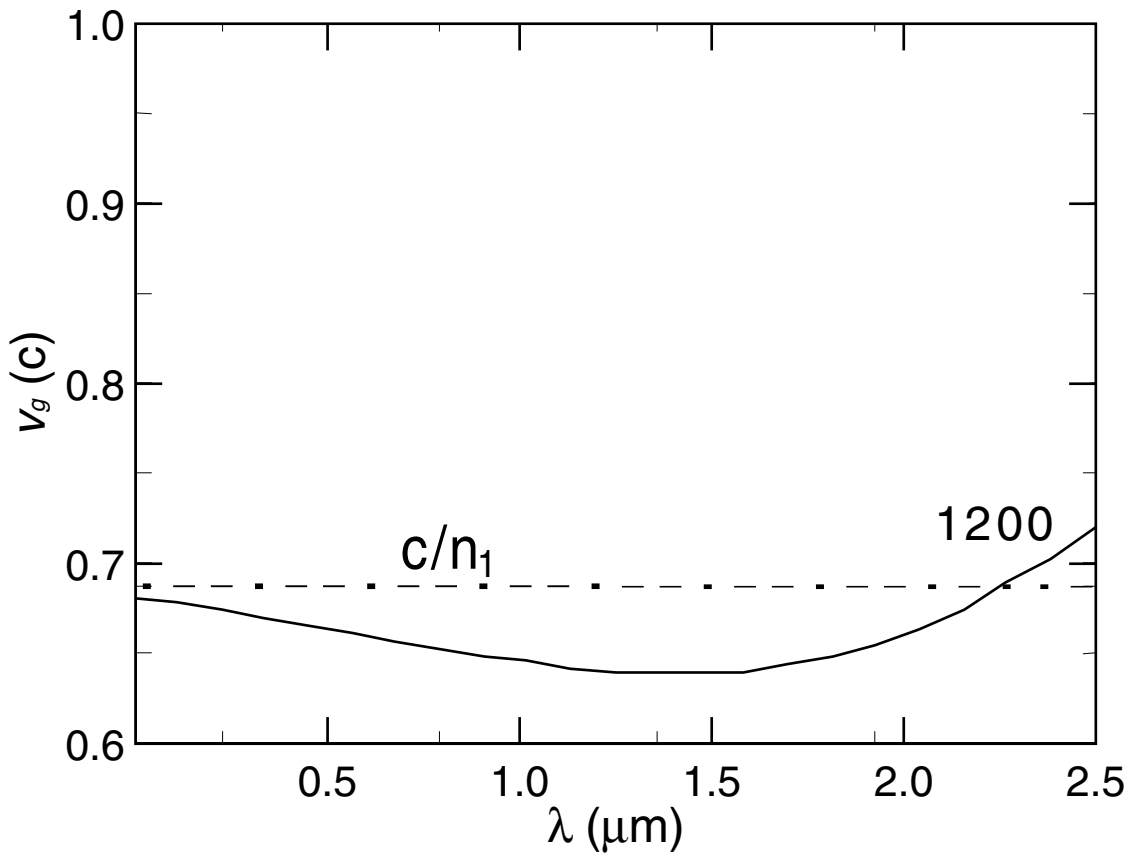
waveguide dispersion



Optics Express, 12, 1025 (2004)

Optical properties

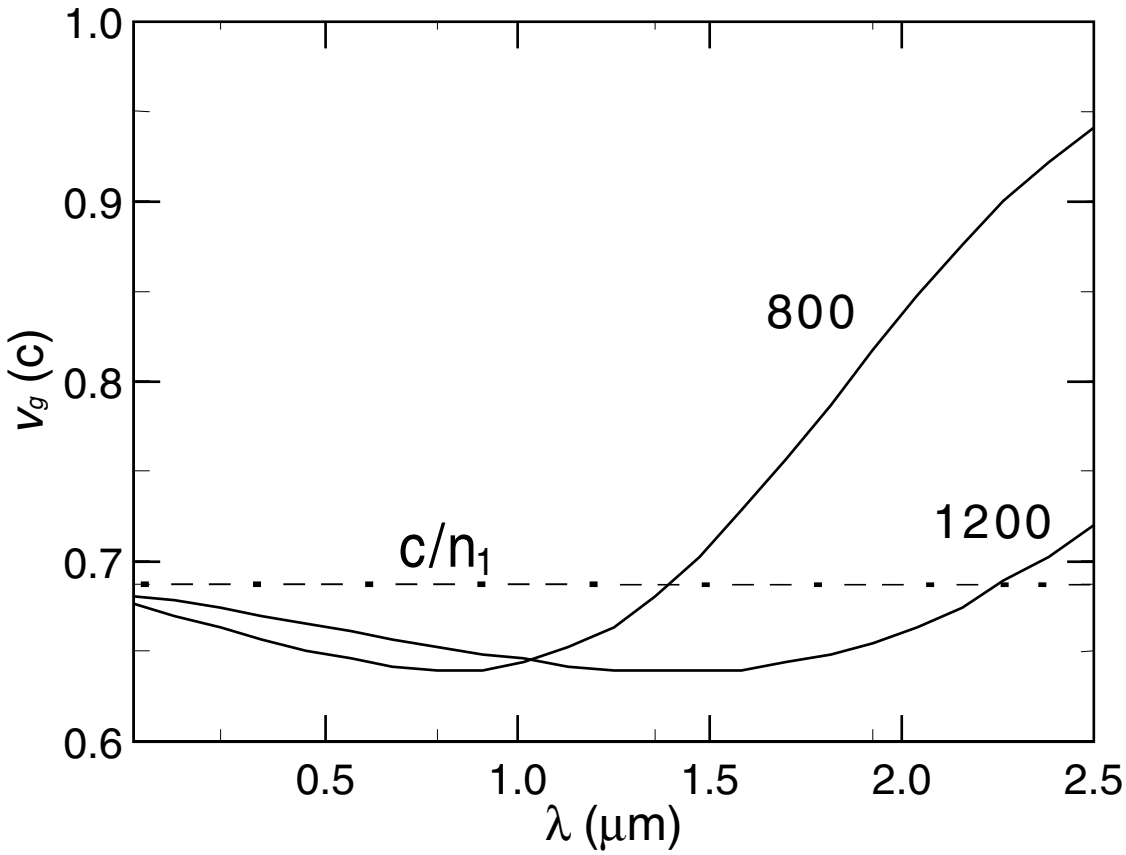
waveguide group velocity



Optics Express, 12, 1025 (2004)

Optical properties

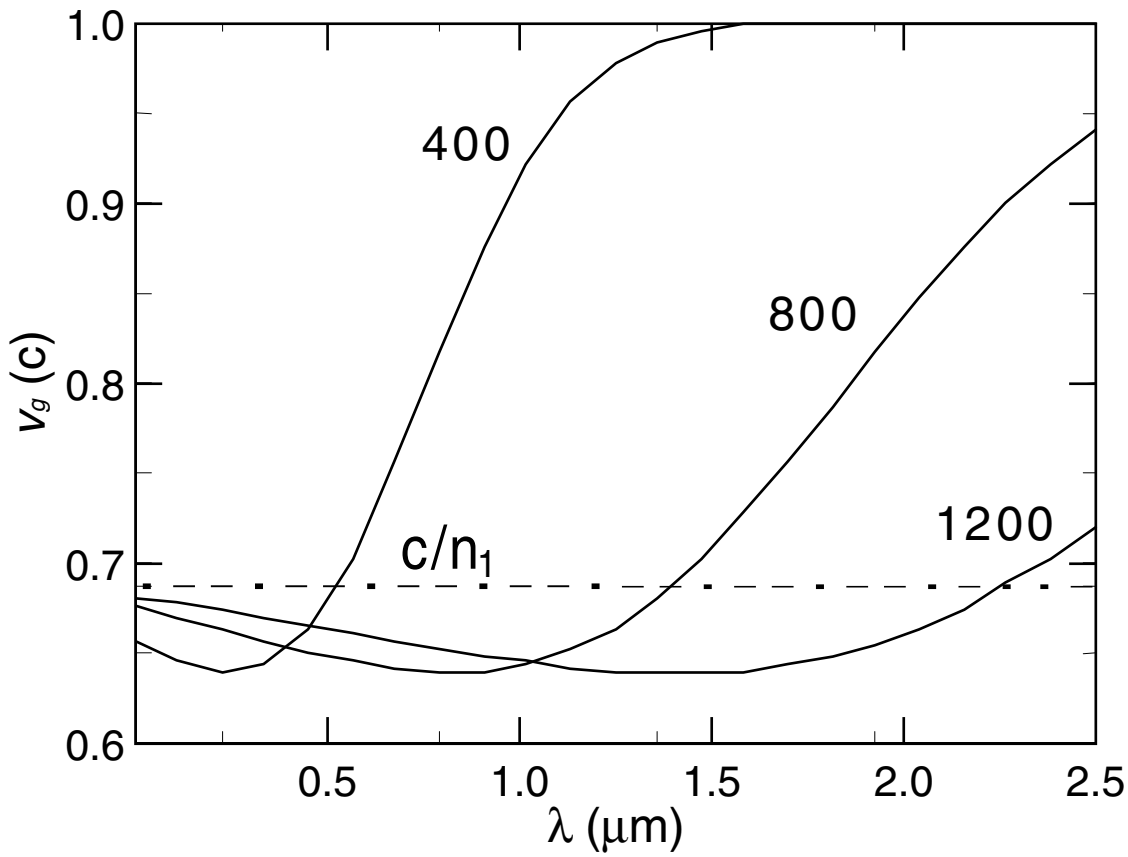
waveguide group velocity



Optics Express, 12, 1025 (2004)

Optical properties

waveguide group velocity

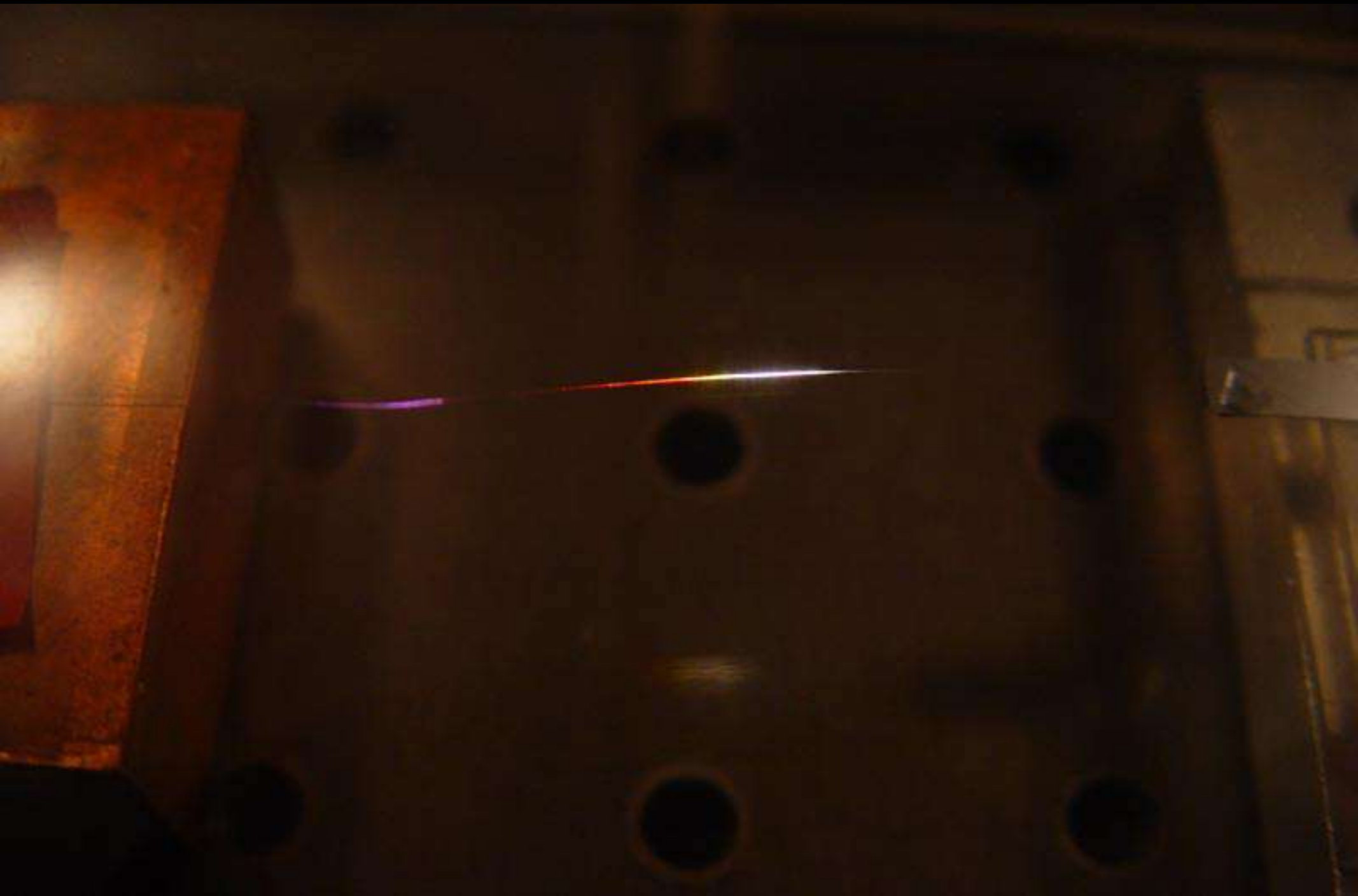


Optics Express, 12, 1025 (2004)

Outline

- nanowire fabrication
- optical properties
- **supercontinuum spectra**

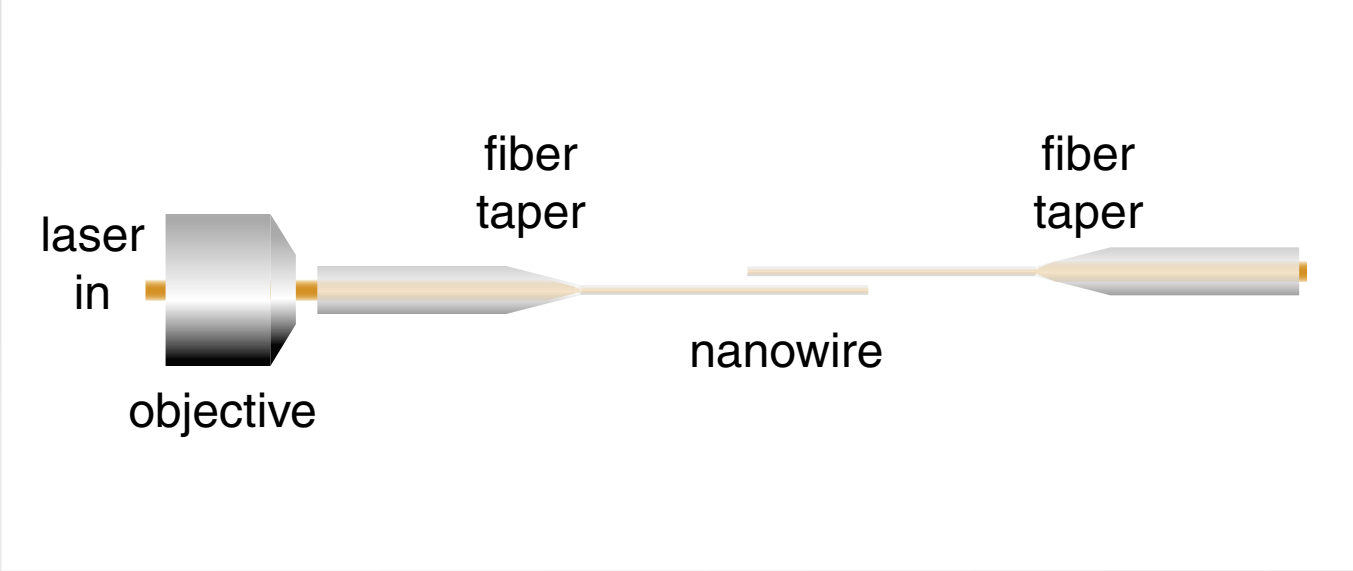
Optical properties



Optical properties

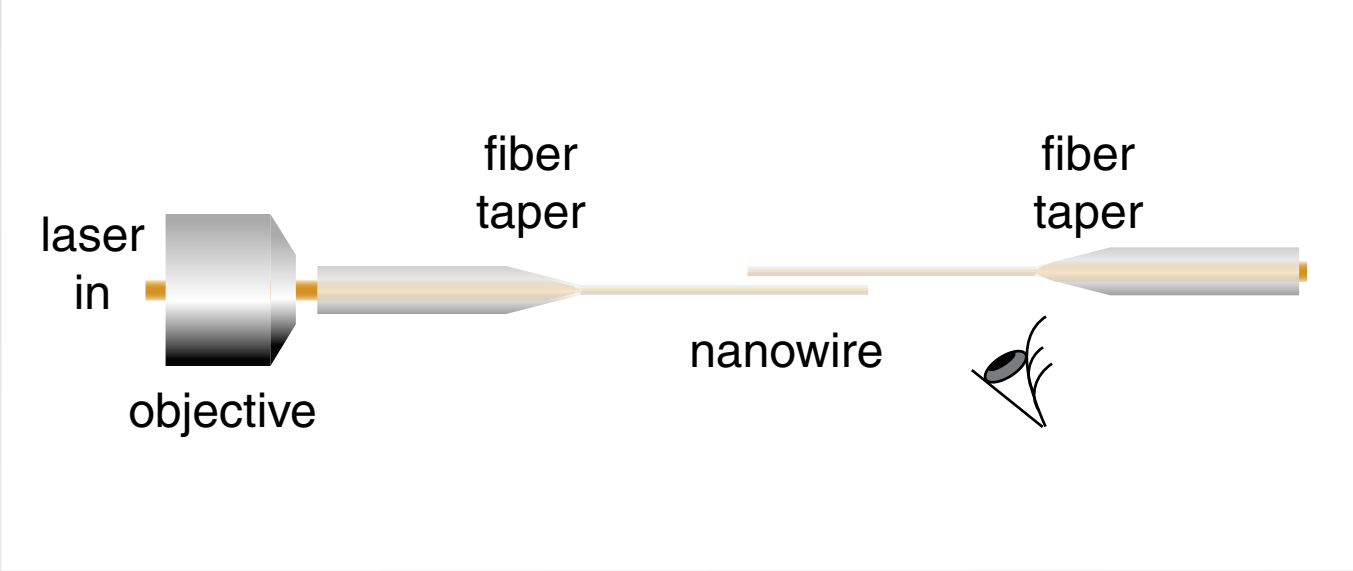
Optical properties

coupling light into nanowires



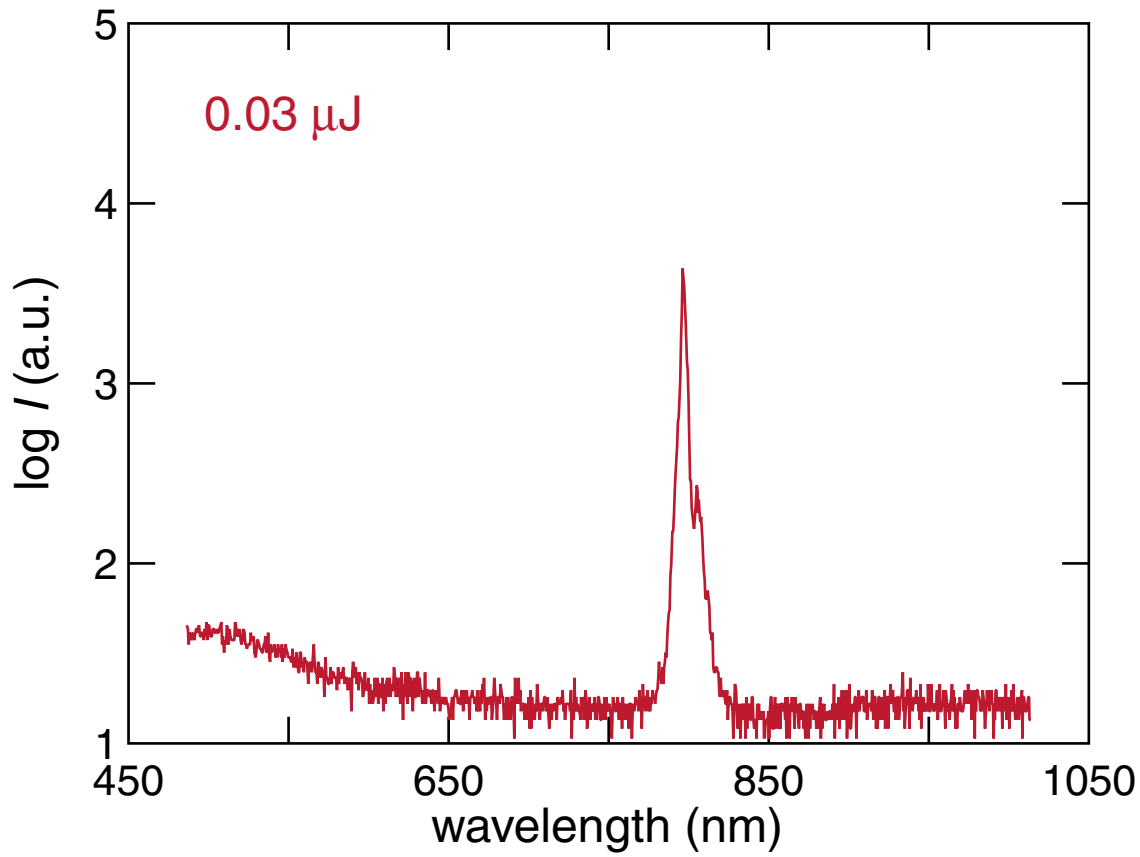
Optical properties

coupling light into nanowires



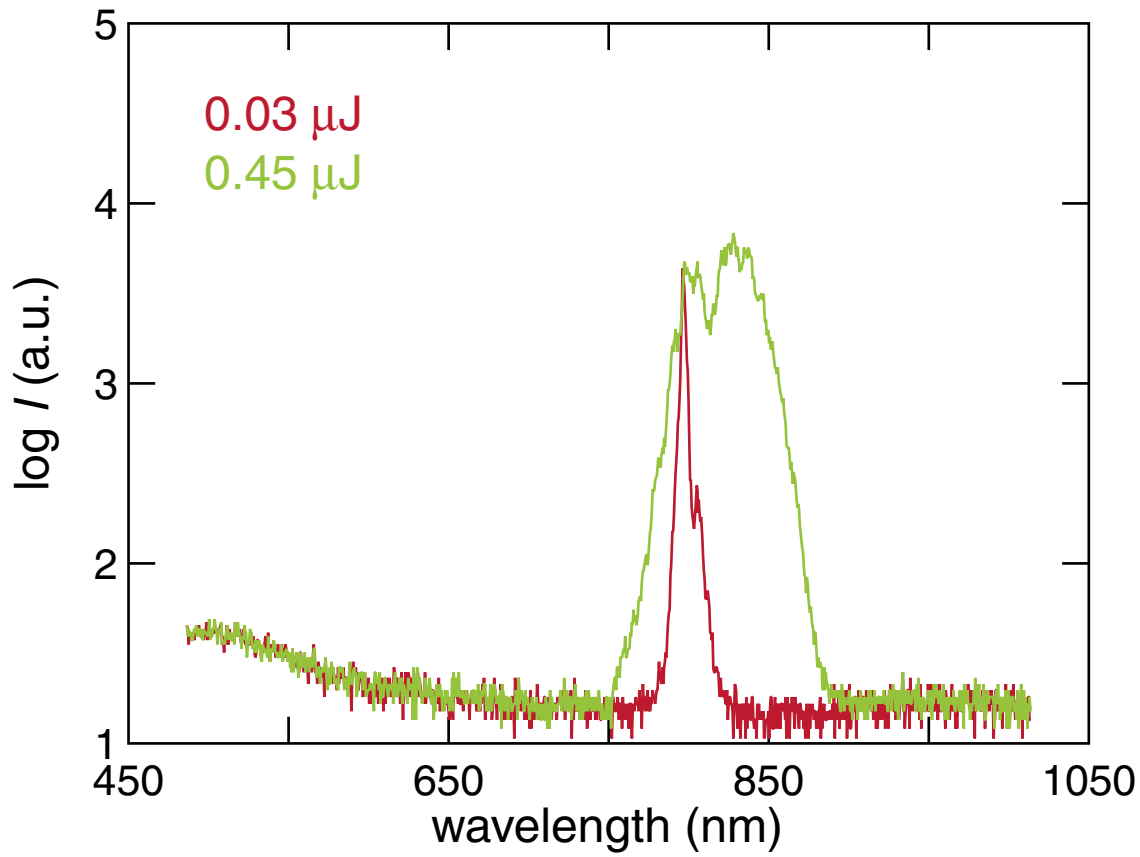
Optical properties

infrared broadening



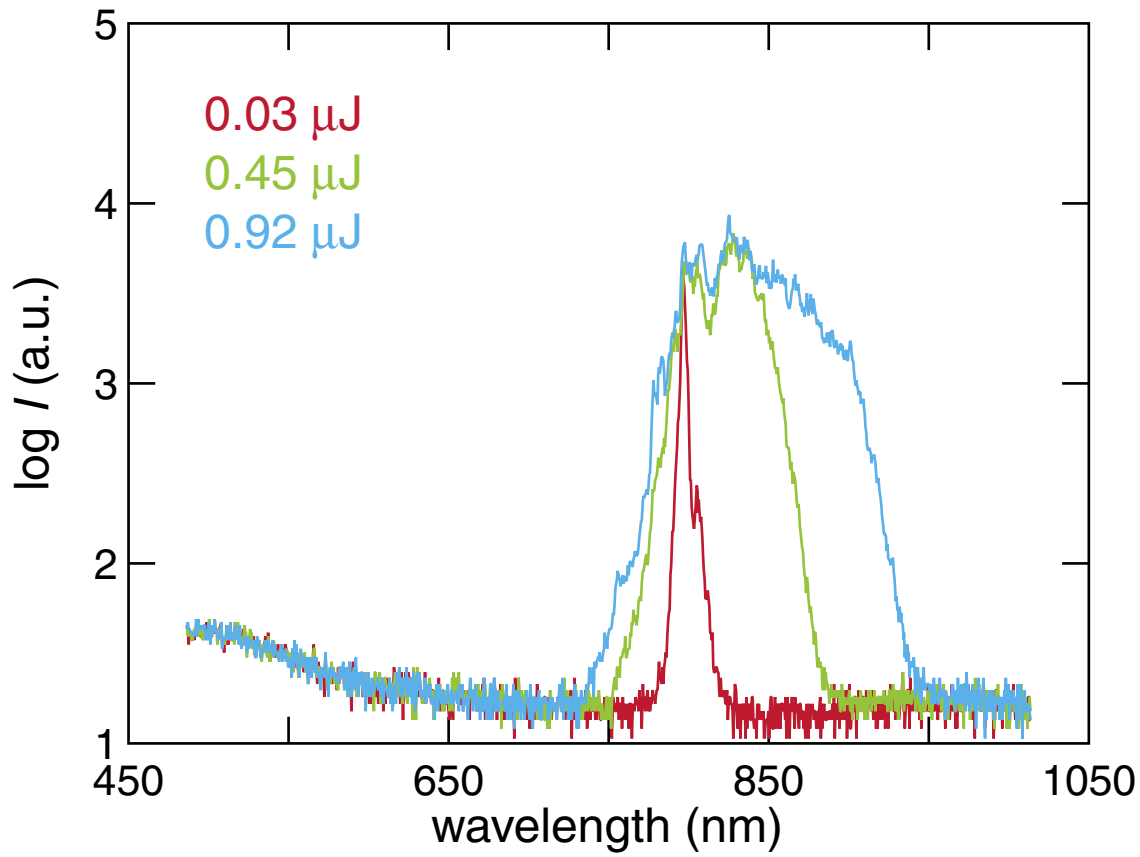
Optical properties

infrared broadening



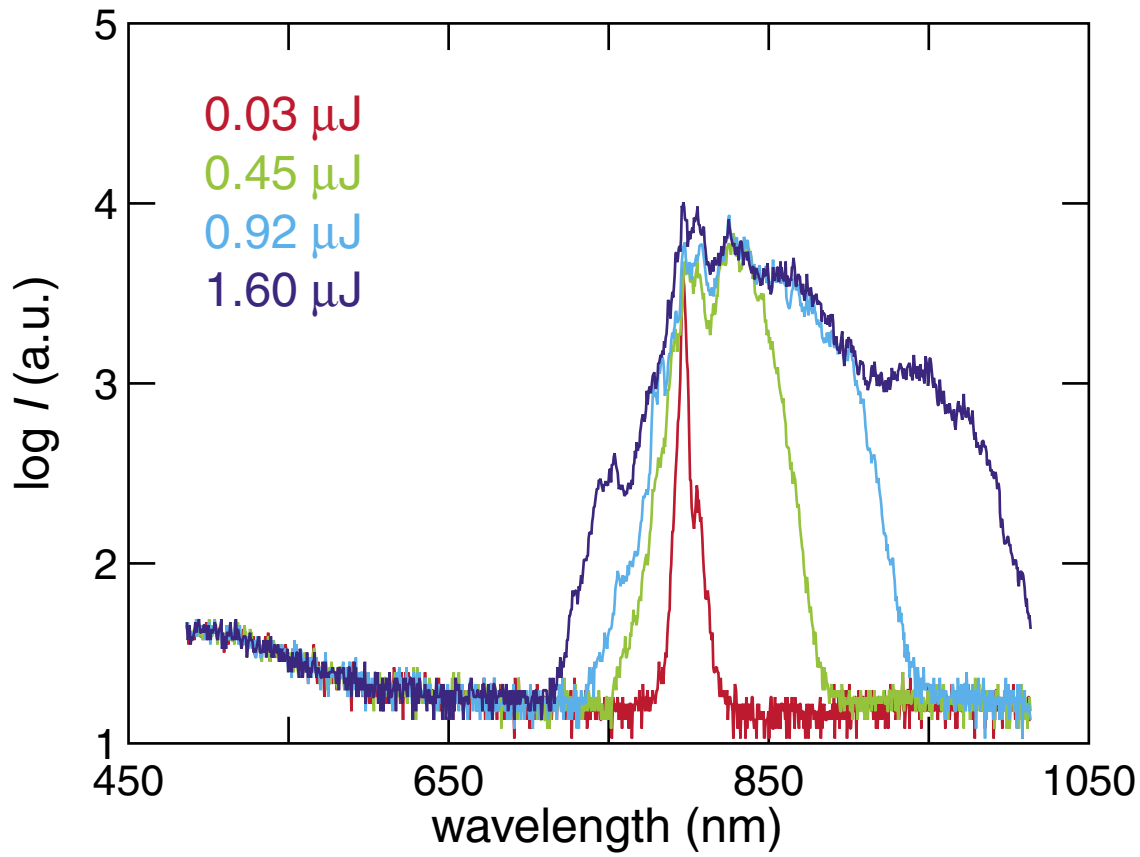
Optical properties

infrared broadening



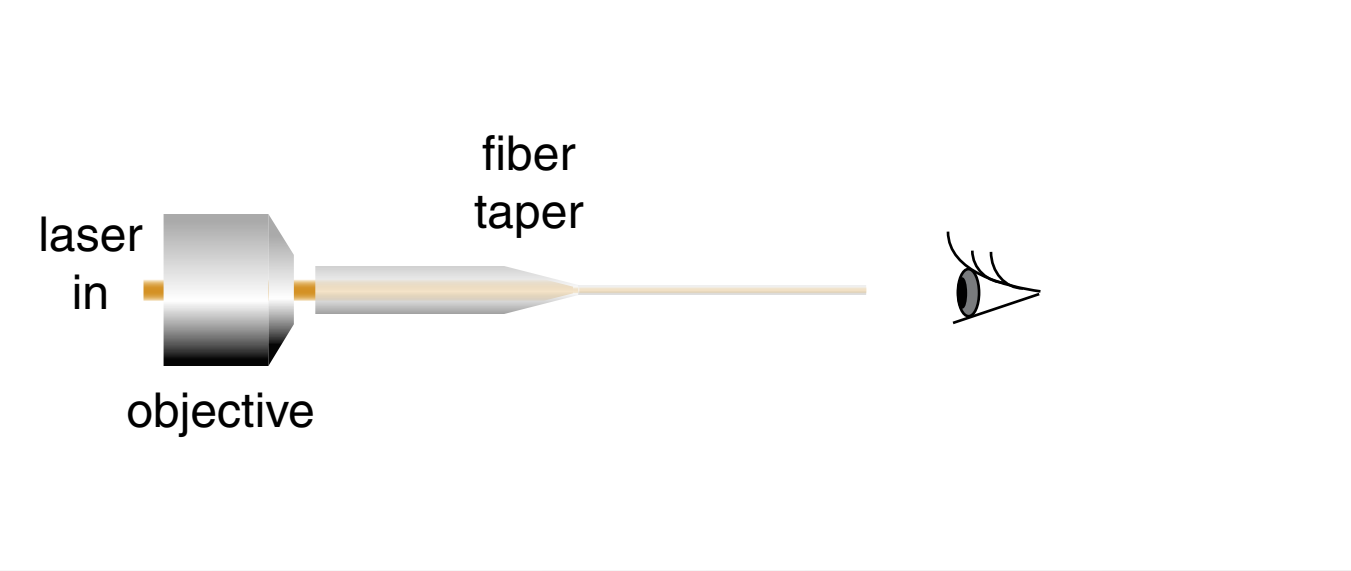
Optical properties

infrared broadening



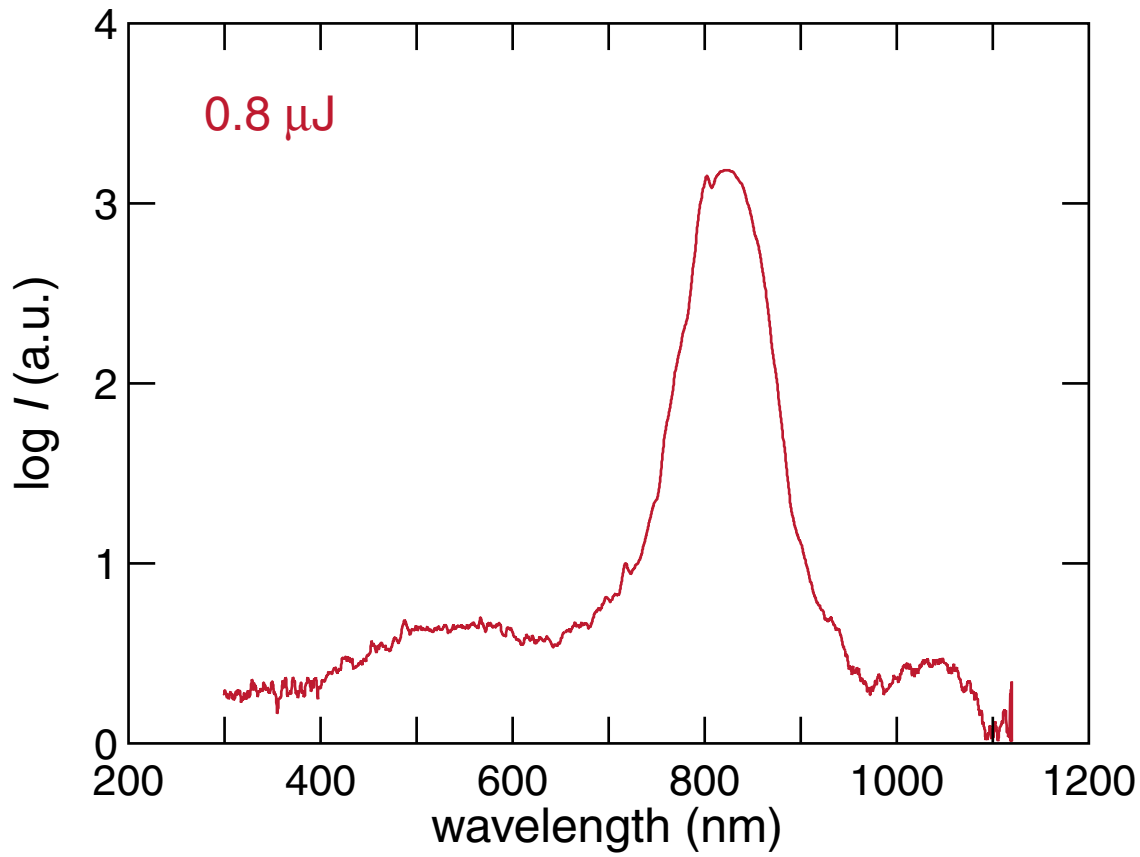
Optical properties

coupling light into nanowires



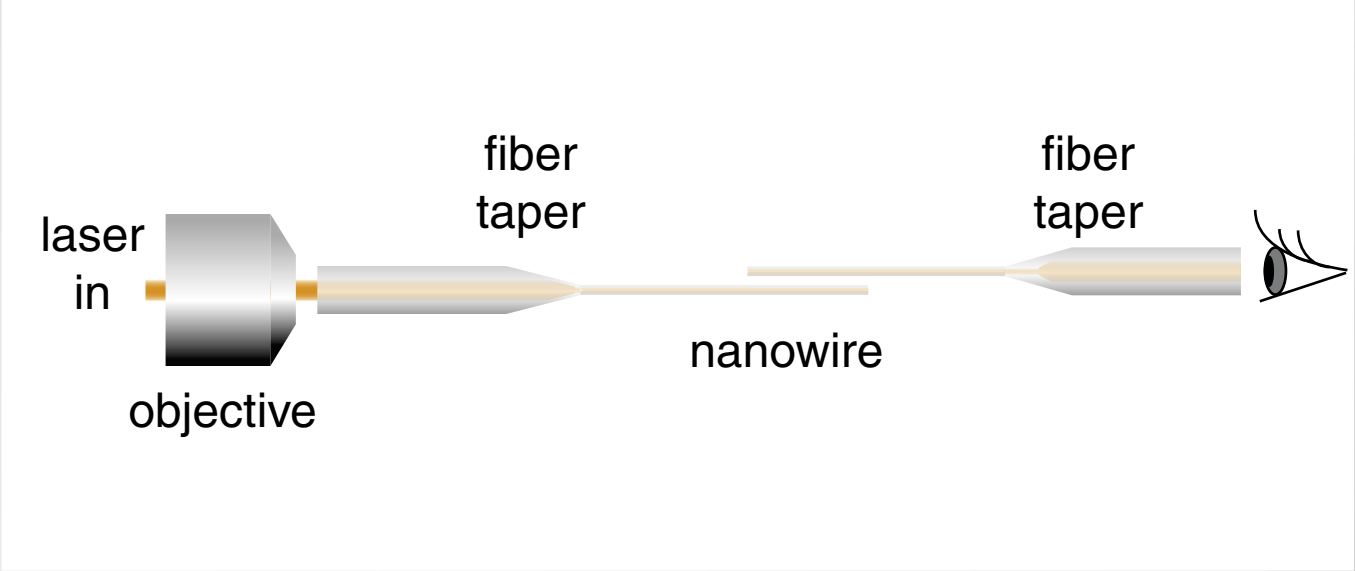
Optical properties

second harmonic



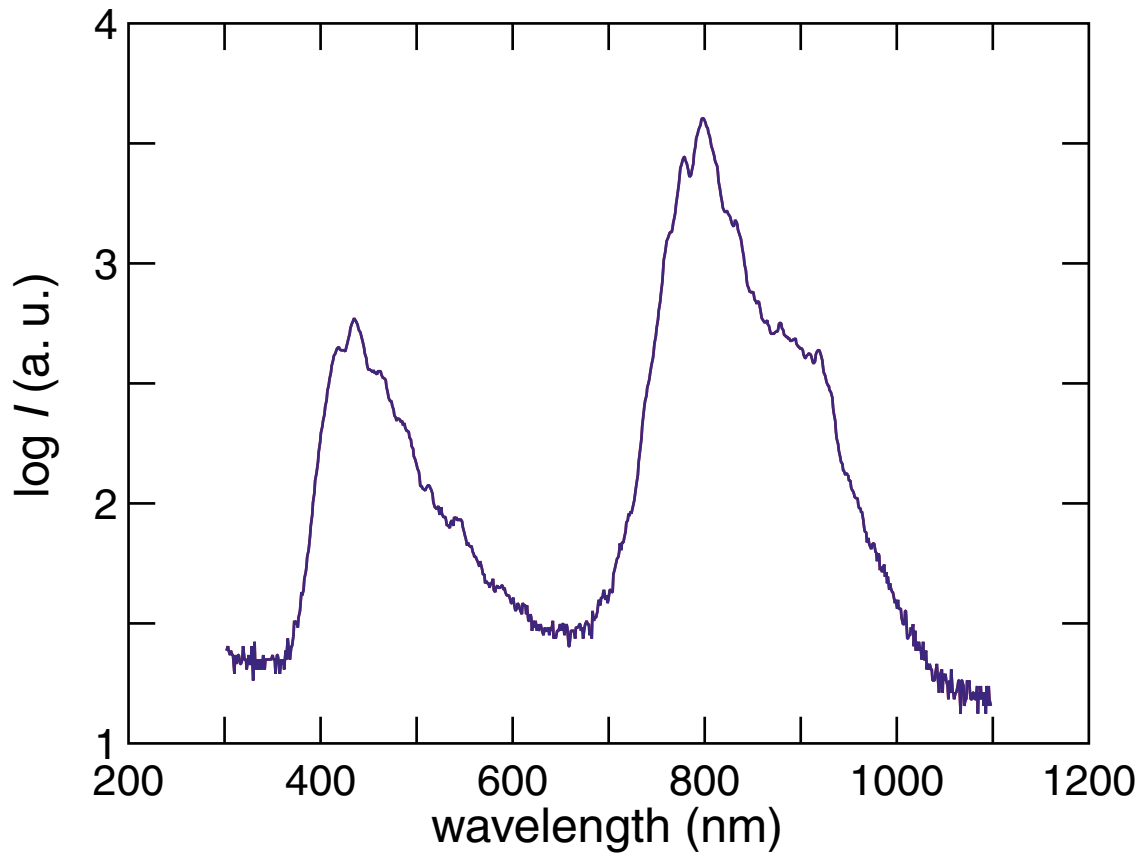
Optical properties

coupling light into nanowires



Optical properties

second harmonic



Summary

- strong confinement
- negative dispersion
- large evanescent wave

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