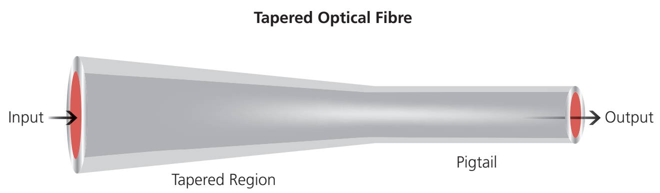
Tapered optical fibers
TAP Series

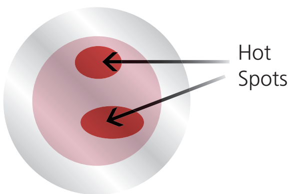
OXFORD ELECTRONICS
Manufacture and supply of specialised optical fibers

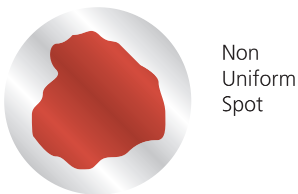
- For high power laser transmission



Tapered optical fibers are an efficient method of transforming a poor quality laser beam into a spatially uniform spot. An ‘ideal’ laser would have a circular output beam with a linear power distribution across the spot and this would remain constant at varying power levels. In practice many high-powered lasers are far from ideal and can have non-circular outputs that can contain local hot spots. In addition the shape of the output beam can vary with varying power and with the lifetime of the laser. These effects can cause loss of power transmission and damage to a conventional fiber if the threshold of damage is exceeded.

By using a tapered fiber, a larger input core diameter can be used which can reduce the power per unit area by factors of 10 or more and at the same time allow all the energy from the laser to be transmitted.





When choosing an optical fiber for high powered laser use it is frequently found that damage occurs to the input of the fiber which forces the use of a large diameter fiber and consequent loss of flexibility. Use of a tapered optical fiber means that a large diameter input can prevent input damage and allows a smaller diameter pigtail for convenience. They are also useful for a wide range of optical applications including the transformation of monochromater output slits into optical fibers.

The concept of conservation of brightness states that, provided the light losses are negligible, the spatial and angular parameters of light anywhere within or at either end of the taper are mutually connected by:
$S_i n_i^2 \sin^2(v_i) = S_O n_O^2 \sin^2(v_O)$

n = refractive index of the medium v = measured angle subscripts i and o refer to input and output.

Since nsin(v) =NA and Si/So =R^2

where R is the core diameter ratio, it follows that, NA_O/NA_i=R

To ensure maximum efficiency of light transmission, the NA of the light entering the taper input should be 0.22 divided by the taper ratio. E.g. suppose the input core diameter of the taper is 2.0 mm and the output core diameter is 1.0 mm (taper ratio =2) then the NA of the light entering the taper should be less than 0.22/2 =0.11. If this rule is observed, losses in the taper will be comparable with the HPSUV and HPSIR fibers and therefore for most practical tapered fibers, losses will be negligible. This is not the case with most conventional white light sources that usually have a high NA and light will then escape in the tapered region.

Fiber specification

Fiber type
Step-index multimode

Core material
Pure synthetic silica

Cladding material
Doped synthetic silica

Maximum core diameter
4.2 mm

Max I/P to O/P core diameter ratio
5:1

Taper length range
0.5-3 m

Pigtail length
0-15 m

Numerical aperture
0.22

Coating
Acrylate

Operating temperature
-400°C to + 850°C

Damage threshold
100kW/cm²

An application note is available for tapered fibers.

Ordering information

TAP U 2000/1000/1/3

- Total length in meters
- Taper length in meters
- Output core diameter in µm
- Input core diameter in µm
- U = UV grade, I = IR grade
- See HPSUV and HPSIR fiber for spectral attenuation data

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Tapered fibers can be supplied in plastic or stainless steel jackets with SMA or other connectors fitted.

Example of custom fitting for laser output connector.