

APPLICATION NOTE

No. 24 8/27/93

Dispersion Shifted Fibers

Single-mode Fibers

The fibers commonly used in nearly all present optical fiber link installations are single-mode fibers optimized at 1300nm. They are characterized by having minimum dispersion around a wavelength of 1300nm and a cutoff wave length such as to allow for safe operation in terms of attenuation and modal noise at the operational wavelength.

Generally speaking, these fibers propagate most of the optical power in the core region. At longer wavelengths, a larger fraction of the optical power propagates in the cladding region, and this accounts for a slight increase in waveguide dispersion.

Operation at 1310nm for singlemode fiber is the point where the attenuation and dispersion lines for the fiber intersect. Before this point, attenuation is higher and dispersion is lower. Past this point, attenuation is lower and dispersion is higher. It would be advantageous to operate in the 1550nm region and gain the lower attenuation if not for the higher dispersion which decreases the bandwidth.

Dispersion

Dispersion is the spreading of the light pulse as it propagates through the fiber. There are three classifications of dispersion for optical fibers:

1. *Modal Dispersion* - Light traveling through the fiber follows different path lengths, causing a spreading of arrival times at the distant end. This is a problem primarily in multimode fibers.
2. *Material Dispersion* - Material dispersion is due to the wavelength dependence of the glass refractive index, which affects the group velocity. Since the light pulse is not monochromatic, slightly different wavelengths of light propagate through the fiber's core at slightly different speeds.
3. *Waveguide Dispersion* - Light propagates in both the fiber's core and cladding. Due to the difference of index of refraction between the core and cladding, arrival

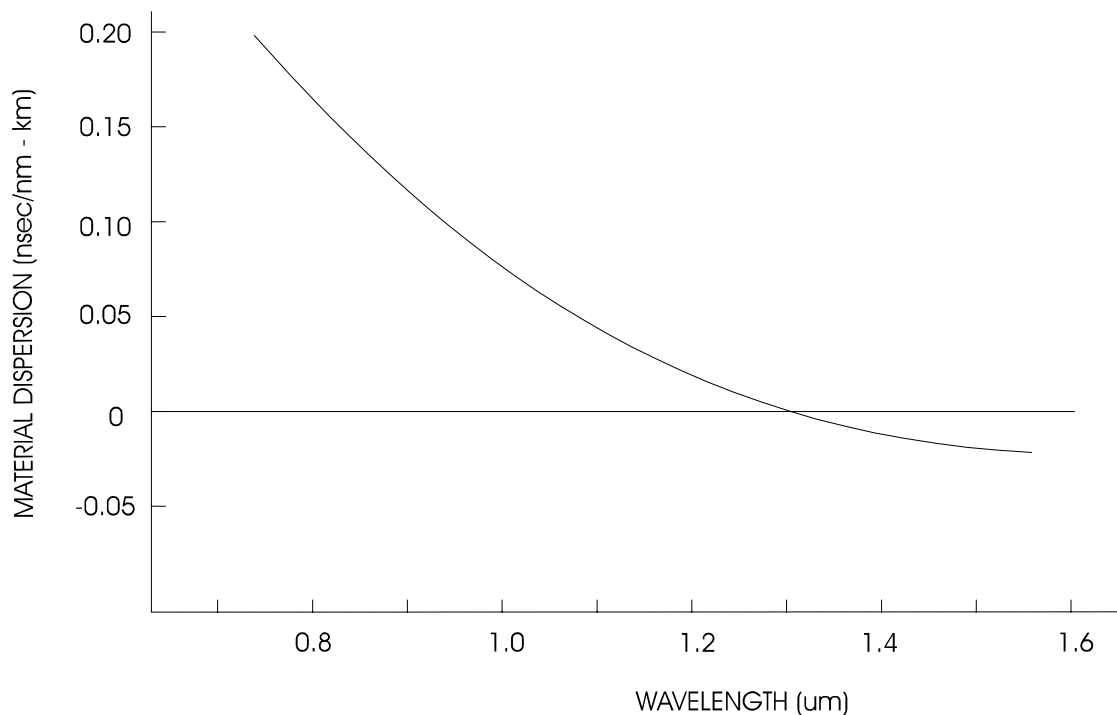
time at the distant end for each will be slightly different. The result is a spreading of the light pulse. Waveguide dispersion is most significant in singlemode fibers.

Dispersion Shifted Fibers

Minimum loss of silica optical fibers occurs in the 1550nm region. If some way could be found to also have minimum dispersion in the same region it would be the ideal operating wavelength. Low loss and high bandwidth.

This can be achieved by suitably shaping the refractive index profile of the singlemode fiber. The fiber profile should be such as to allow a comparatively large fraction of optical power to propagate in the cladding region. This will increase waveguide dispersion, thus providing a larger compensation of material dispersion.

In singlemode fibers, waveguide propagation effects can cause a wavelength dependence of the singlemode propagation constant which is similar to material dispersion. It can have a sign which is opposite to that of material dispersion, with the effect that the frequency of zero net dispersion is shifted. Simply put, waveguide dispersion can cancel out material dispersion.



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