



## LED vs. Fiber Optic Illumination

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Today's microscopes offer an extensive selection of light sources to suit individual preferences, technical requirements and workplace conditions and applications. While users appreciate the various options available to them, selecting a light source to meet their specific needs can be overwhelming. What follows below is a comparison between the two most common microscope light sources: LED and Fiber Optic.

As with many light sources, the balance between energy consumption, light output, color temperature and lumen maintenance requires a careful understanding of the tasks which are to be performed. While Fiber Optic lighting is preferred for jobs such as wire bonding or soldering of fine-pitch components, pure white LED light is preferred for the detailed inspection of circuit boards, welds, solder joints, flux residues and hairline stress cracks.

### Energy Consumption

An ideal light source will produce the greatest amount of light while using the least amount of energy. Numerous LED and Fiber Optic light sources available today provide dimming options which help to lessen energy consumption and increase lumen maintenance. Today's technicians are always searching for the most energy-efficient alternative to meet their inspection and assembly needs.

LEDs typically consume between 9- and 18-watts of energy while producing 3600 footcandles at 4.5' working distance. While this undeniably makes LEDs the more energy-efficient lighting solution (Fiber Optic lighting consumes approximately 150-watts), Fiber Optic lighting produces 6450 footcandles at roughly 4.5" working distance.

LED's are considered the most energy-efficient light source available on the market today. But how can they be when Fiber Optic lighting clearly produces greater footcandles?

The reason involves the controlled and directional illumination produced by Fiber Optic lighting compared to the broader distribution produced by LEDs. Fiber Optic Illuminators as purchased for use with

microscopes feature dimmable 150-watt halogen light sources and are used in conjunction with one of two light transmitters: Continuous Ring Lights or Dual/Single Goosenecks.

Fiber Optic Continuous Ring Lights are the most popular light transmitters. Constructed with high-quality glass fibers they provide 360° shadow-free uniform illumination and provide good contrast for viewing without eyestrain. A 36" length cable, constructed of interlocking stainless steel sheathing, enables the illuminator to be positioned outside the immediate work area for greater flexibility in inspecting or assembling. A dimmer switch enables the operator to further control the intensity of the 150-watt light source.

The Dual Gooseneck has two 18" wands, made of stainless steel obedient sheathing, which can be focused at a point to provide intense, shadow-free illumination. An 18" Single Gooseneck is ideal for looking into small, crevice-like openings or inspecting the inside of a tube or cylinder. Both Dual and Single Goosenecks include an adjustable lens at the end of each wand so the operator can change the focus of light from a narrow, intense beam to a wider, more diffused pattern.

Therefore, although Fiber Optic lamps produce greater footcandles, they do so while drawing considerably more energy than LEDs. Consequently, LEDs are considered the more energy-efficient alternative as they produce maximum footcandles while using minimal energy.

### Color Temperature

Color temperature is directly related to the coolness or warmth of a light source. Cool light (with a color temperature of roughly 3600°K-5500°K) produces greater color contrast and is better suited for inspection tasks, while warmer light (with a color temperature of roughly 2700°K-3600°K) is better used for ambient lighting purposes. Light sources with higher color temperatures are better at discerning gloss and allow for "true color" rendition across a wider range of colors. The higher the color temperature of a light source the more blue and green it contains. As opposed to red and orange colors, blue and green make a light source appear both whiter and brighter.

With a 6000°K color temperature, LED lighting enables the user to best examine the “true color” of objects as they are inspected. LED Ring Lights as used with microscope inspection systems are ideal for lead-free solder applications as they minimize any glare from glossy surfaces.

Fiber Optic lighting has a 3500°K color temperature making it preferred for applications which have less color variation.

## ROI

Lumen maintenance refers to the amount of output a lightsource produces over a given amount of time. Expressed in hours, lumen maintenance, or lamp life, is the point where a light source has lost 30-50% of its initial lumen output. This is the level when it becomes visible to the human eye that a new light is ‘brighter’ than an old.

LED’s are notorious for their extensive lumen maintenance. Typical LEDs used with microscope inspection systems have a lumen maintenance of 50,000 hours (based on a 30% loss of lumen output) when used at full intensity. This equates to nearly a 21 year lamp life. The lumen maintenance will be extended if it is used with a dimmer switch.

EKE lamps are the preferred lamps for use with Fiber Optic Illuminators when they are paired with Ring Light or Gooseneck transmitters and used for microscope inspection systems. EKE’s are rated for a 200 hour lumen maintenance when set to full intensity. When used at 80-85% intensity, the lamp life doubles, and when used approximately 60% intensity the lamp life increases up to nine times. Without the use of a transmitter, EKE lamps have a ‘flood-light’ illumination pattern so less of the light output is directed through the fiber bundles. This means, as a rule of thumb, the dimmer switch will be turned to a higher setting.

However, depending on the intensity of light an operator needs to see well, the EKE lamp may provide sufficient illumination at a moderate setting and, in these cases, will be more economical to use as the light source.

The real benefits of lumen maintenance as produced by LED lamps are appreciated when you consider the return on investment:

$$\text{ROI (months)} = (\text{LED End User Cost} / (\text{FO End User Cost} + \text{FO Replacement Cost})) \times (52 / 12)$$

E.g.  $(\$790 / (\$17.00 + \$8.33)) \times (52 / 12) = 7.2 \text{ months}$

As you can see, the cost benefits of using LED lamps instead of Fiber Optic are realized in 7.2 months. Given this obvious cost savings as a result of longer lumen maintenance LED’s are an economical alternative to traditional fiber optic lighting.

## In Conclusion

While ideal for use in assembly and inspection applications, the intensity of Fiber Optic lighting makes it difficult for use in high-gloss environments or for purposes which may require the user to distinguish between differences in color. LED light however provides the best combination of benefits. Energy-efficiency, dimmable illumination, high lumen maintenance, and high color temperature all combine to give the user maximum performance for microscope inspection and assembly applications.

