SYNCPOWER
White LED Performace

Light Emitting Diodes (LED) have recently become available that are both white and bright, so bright that they seriously compete with incandescent lamps in lighting applications. They are still pretty expensive as compared to a GOW lamp but draw much less current and project a fairly well focused beam. The diode in the photo came with a neat little reflector that tends to sharpen the beam a little but doesn't seem to add much to the overall intensity.

When run within their ratings, they are more reliable than lamps as well. Red LEDs are now being used in automotive and truck tail lights and in red traffic signal lights. You will be able to detect them because they look like an array of point sources and they go on and off instantly as compared to conventional incandescent lamps.

When used as a locomotive headlight, the effect is quite good. The Big Hauler on the left has a Radio Shack 12v 60 mA Grain-Of-Wheat bulb running at its ratings. The Shay on the right has the stock Bachmann bulb that came on the early production Shays, later Shays have a much more wimpy standard yellow LED as a headlight. You can see that the Big Hauler light is not very bright as compared to the Shay.

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This photo shows the same two engines after a bright white LED has been installed in the Big Hauler. The LED is running at its rated 20 mA vs the 60 mA that the old GOW bulb took. Now compare the brightness of the two locos using the Shay as a reference to see how much brighter the white LED is.

The LED produces a tight bright beam that goes further down the track than most incandescent lamps. In a dark environment, it is bright enough to cast shadows more than 10 feet away. In the indoors environment, the LED might be too bright. These trains run at eye level and when the beam sweeps across my eyes, it is blinding.

The viewing angle and the brightness of LEDs usually vary inversely. A wider angle will result in lower brightness in any given direction as the total light output of the LED is spread over a larger area. For headlight applications, a 20° viewing angle is appropriate. This is the tightest angle typically available and produces the most intense beam in front of the loco. Intensity is rated in candlepower, a typical tight beam LED runs 4000 to 5600 mcd. The size of the diode package determines the minimum beamwidth, a larger package with a larger lens can focus a tighter beam. For most large scale headlight applications, a 5 mm diode package is adequate. There are 10 mm packages available that will produce a tighter beam, but a 10 mm (0.4") LED is really too large to mount on a loco.

This tight beam aspect of many of the white LEDs has a downside also. The tighter the LED beam, the dimmer it will appear when viewed off angle. Some of them have such a well formed beam that they are hardly visible at all at angles between 30 and 80°. At almost 90° they have a sidelobe and are visible again. A regular frosted diffuse LED, such as Bachmann and Aristo use, may appear brighter than a tight beam white LED in the daylight when viewed off angle because they spray light in all directions. However, the diffused wide angle LEDs have no hope of casting any sort of a beam in dim light or darkness. White LEDs with a different shaped (usually smaller) lens will have a wider viewing angle, but do not form as tightly a focused beam. They light up the general area in front of the loco instead of casting a beam down the track. There really is no free lunch.

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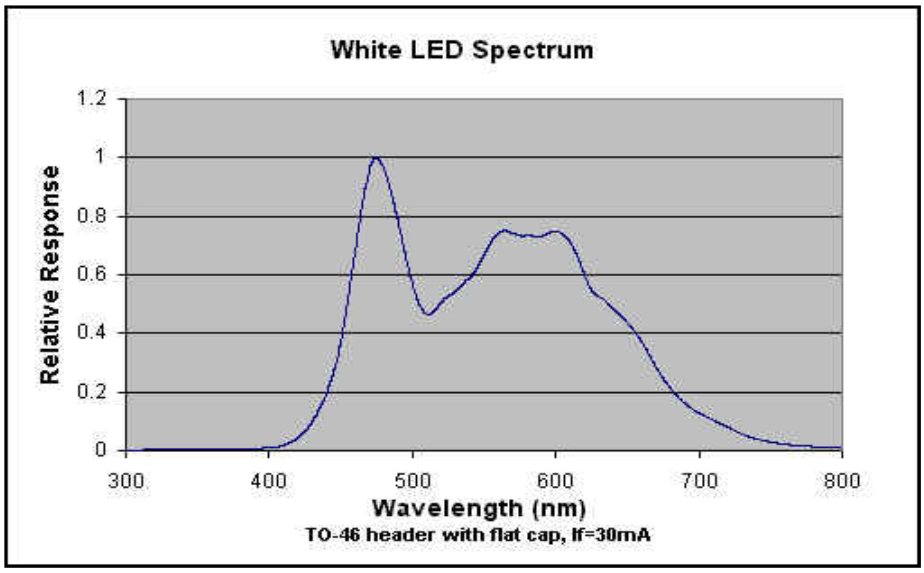
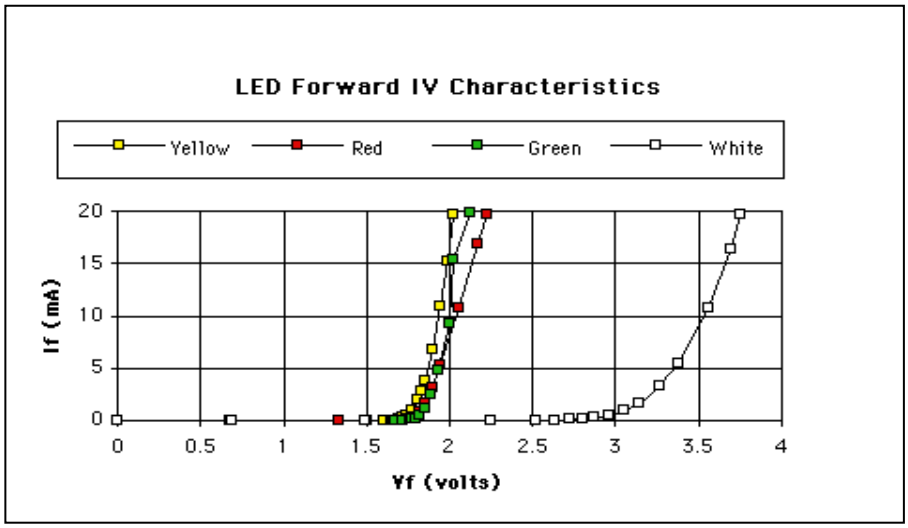


LEDs are monochromatic (one color) devices. The color is determined by the bandgap of the semiconductor used to make them. Red, green, yellow and blue LEDs are fairly common. White light contains all colors and cannot be directly created by a single LED. The most common form of "white" LED really isn't white. Its a Gallium Nitride blue LED coated with a phosphor that, when excited by the blue LED light, emits a broad range spectrum that in addition to the blue emission, makes a fairly white light. The actual light has a blue cast and is similar in color to a mercury vapor street lamp. On the curve shown, the peak at the left is the shortest wavelength blue light from the LED. The lump of emission to the right is the longer wavelength emission of the phosphor. There are other types of "white" LEDs that are made from several different LED chips of different colors assembled into one package. These have not been particularly successful as they tend to change color depending on viewing angle and their color balance is not real good at best.



There is that these white LED's have a limited life. After 1000 hours or so of operation, they tend to yellow and dim to some extent. Running the LEDs at more that their rated current will certainly accelerate this process.