Component Engineering

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Why “Dye Tracks”?

Way back when sound was first put on film, all film was black and white, and the black was made of silver—real metallic silver. Being a metal, it made no difference what kind of light was used to scan the sound track. This worked just fine until modern color films came along (remember that Technicolor IB was a series of dyes applied to what was still a black and white film stock onto which the sound track had already been exposed and processed). These modern color films start out having three layers of silver based emulsions, each sensitive to a different color. When the film is being processed, these layers are developed into what really are three layers of black and white images. Then the silver in each is removed and replaced with appropriate dyes in order to yield the color image we want. The trouble is that each of the three-color dyes passes only a small portion of the spectrum, but it is enough to convince the human eye and brain that it is seeing all the colors it is accustomed to seeing. (See Figure 1, which was lifted from Kodak’s data sheet for color positive film type 5384.) For the sound track, however, there is an even bigger problem, and this has to do with the nature of a normal tungsten filament light bulb.

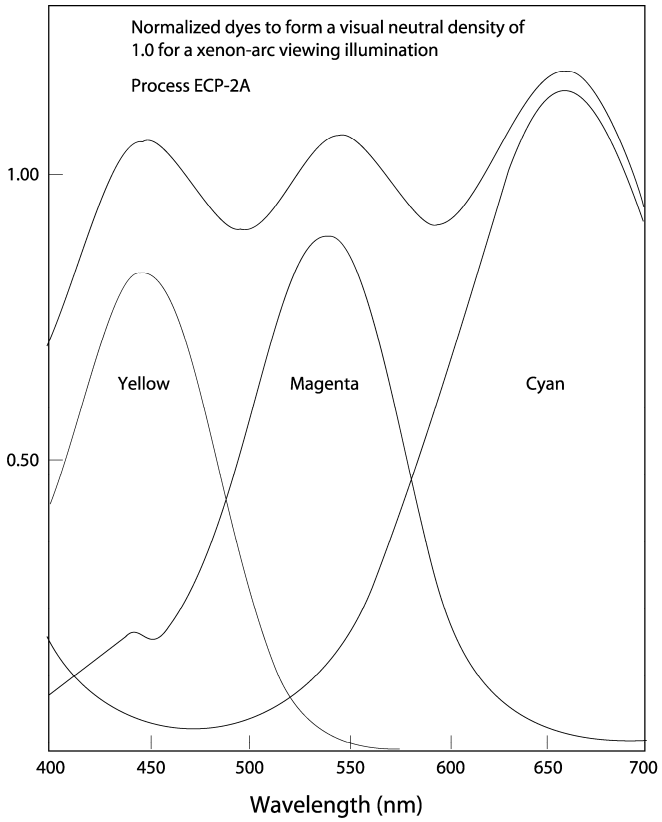
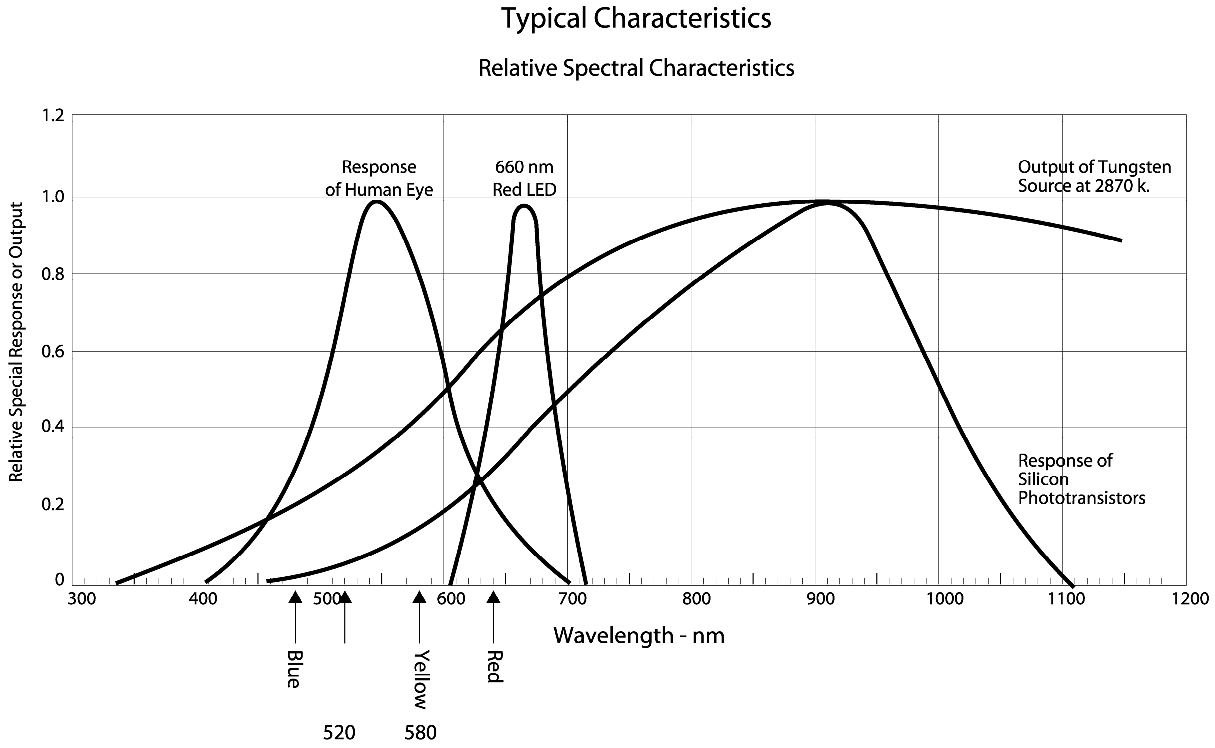


Figure 1

This light bulb, be it the one in your desk lamp or the exciter lamp in your sound head, is really putting out most of its energy up in the infra red part of the spectrum. That's why it gets so hot. We humans don't care about all that infra red that we can't see because we still get enough visible light to see by. See Figure 2, however, and note how well the curves for the Tungsten source and the Silicon Phototransistor Response correspond. They both love all that infrared.


Typical Characteristics

Relative Spectral Characteristics

Figure 2

This was a happy situation until black and white film disappeared and left us with three layers of dye which are totally transparent to infrared light. Look again at Figure 1 and extrapolate the Cyan curve on out and you can see that it will be gone before we get into the infrared region. Therefore, very little light will get modulated on its way from the exciter lamp to the photocell and so very little sound will be heard.

The solution to this has been to amend the processing of the track area only such that the original silver from the emulsion is held in the film so that it can modulate all this infra red light. This is not easy to do. The processing laboratory now has to apply a chemical solution to a part of the film that is less than a tenth of an inch wide, leave it there long enough for the reaction to take place, and then wash it off again without ever allowing any of it to get into the picture area. Not only that, but it is a part of the film which is right next to one edge of the picture that they need to protect. It is when this control slips a bit that you sometimes see dark blobs on the left side of the screen. These blobs come from some of the "re-developer" or "application" fluid which has migrated over into the picture area. Conversely, when not enough of the fluid gets on the track you will hear the sound blubber as it comes and goes. If you are using infrared LEDs it will be worse.

Consider now that the chemicals used in these solutions are really nasty to both humans and the environment, the numbers of prints being made these days, the speed with which they are being made, the metal left in the film when it is discarded, and you can well understand why it would be wonderful if we could get away from the whole problem.

Referring again to Figure 2, look at the output curve for the 660 nm LED, and note that its peak output coincides with the peak density in the cyan layer of the film. Therefore, reading a cyan dye-only sound track works just fine.

Unfortunately we can’t just run down to Radio Shack and pick up a handful of super bright LEDs and squirt them into our old slit lens. As bright as they may seem to you, they aren’t really. Remember that your traditional exciter lamp is putting out mostly infrared which you can’t see, and so you don’t realize just how much energy is being pumped into the photocell. It takes a lot of that energy to excite your photocell, particularly in the part of the spectrum we want to use. Think about it, if you are using the average 9 Volt/4 Amp exciter lamp, that’s 36 Watts. If you can find a 660 nm super bright LED and operate it in its normal range (20 mA) it will be something like .036 Watts, or 1/1000th the output of the exciter lamp. To be sure, most of the light from the exciter is wasted, but so is much of the LED’s.

So, in order to get enough of this narrow spectrum light you have to do two things. You have to use more LEDs and you have to work them harder. In both cases the thing you have to worry about the most is heat. There is a direct correlation between the operating temperature of the actual LED chip down inside that package, and its life. When you gang up 24 of the chips (as is done in the LEDs, which we buy from Dolby) and do not drain away the heat, their life is measured is seconds, not tens of thousands of hours. Obviously, raising the current to increase their output makes it even worse. Looking again at the LEDs we get from Dolby, not only are there the equivalent of 24 LEDs in one package, but they are mounted as close as possible to a metal substrate so that the heat can be drawn off as efficiently as possible. As copper is second only to silver in its ability to conduct heat, copper is what we use for our LED mounts. You don’t see a lot of cooling fins because the real heat sink is the main frame of the sound head.

Finally, because this light source is so compact, we can tuck it inside the sound drum right behind the film and illuminate the sound track from the rear. This allows us to project the image of the track onto the face of the photocell which also carries the slit mask. Therefore, the separation of the two tracks is controlled almost perfectly and our processors can easily decode the Left, Center, Right, and Surround information.