Light Matters

Designing illumination systems with high-brightness LEDs

There are many interesting uses for infra-red LEDs (IRLEDs). You pass through IR beams when entering an elevator, and of course IR is a common medium for consumer audio-visual remote control equipment. Novel applications for high-power IRLEDs are actually quite broad, extending deep into various industrial, medical, security and instrumentation products. I've written about some of these in the past, such as night vision and sub-cutaneous imaging systems.

A few weeks ago one of our customers asked me about methods to measure the cloudiness (turbidity) of a fluid, as part of a continuous in-situ water quality system. Based on the nature of their application and tight cost constraints, IRLEDs proved to be a near-ideal solution. It might be for you as well- so this month I'll briefly review the technique.

Typically, turbidity measurements are performed on seawater (primarily to quantify detritus) or potable water (quantifying pollutants, contaminants, etc.). The method I recommended relies on optical scattering. IR energy from an IRLED source is collimated and introduced into a cavity through which the fluid flows. A matched IR detector, also collimated, "views" the cavity from another position, nominally at a 90° angle from the IRLED-detector path, as in Figure 1. Since the IR energy travels in a straight line along that path, if there are no particulates encountered in the fluid, little or no energy will be reflected or scattered back to the detector. As the concentration of suspended particulates increases, more energy will be scattered in all directions, with a portion entering the perpendicular "optical portal" axis of the detector. (Alternatively, the detector can be placed in opposition to the emitter, to measure presence by absorption. However- this type of measurement is highly dependent of the color and other characteristics of the particulate, so it is not very useful if the fluid carries mixed suspensions.)

Systems with 90° separation angles between emitter and detector are common, as in Figure 1. Measurements made with such arrangements are often called nephelometric ("nephel" = cloud in Greek).

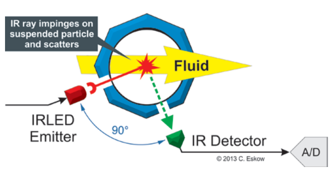

Figure 1 – Simplified arrangement for an IRLED-based turbidity instrument

An 840nm – 890nm IR LED source is used to minimize the detection variance introduced by particle color or composition.

In the real world, many factors impact turbidity measurements- optical characteristics of the "clear" medium (e.g., attenuation, refractive index, even the presence of bubbles), temperature (can change optical characteristics), salinity (can change optical characteristics), etc. Thus calibration to a standardized sample under standardized conditions becomes important when absolute measurements are needed. The most common reference sample is a preparation of formazine (also known as Formazin), a uniform polymer suspension made from of a mixture of hydrazine sulfate, hexamethylenetramine and ultra-pure water.

In my estimation, IRLED emitters with narrow half-angles (radiation pattern) are most useful in these applications; this optimizes the optical coupling efficiency into the collimating elements to/from the cavity. The optical power required is partially a function of the cavity/chamber design and volume, flow rates, the baseline turbidity of the medium, detector sensitivity, etc. Avnet (Americas) and EBV (Europe) provide Osram IRLEDs such as the SFH4550, SFH4650/4655, SFH4715S which often meet all of these requirements.

Figure 2 – SFH4550 (70 mW, 3°), SFH4650/4655 (60 mW, 15°), SFH 4715S (1W, 45°)

There are many suitable IR detectors as well. The BPY62 is both spectrally-matched and has a narrow half-angle (8°); this may simplify the turbidity instruments' design considerably. In general, photodiodes and phototransistors have wide spectral sensitivities, so I suggest an IR pass-band filter to reduce interference from stray light. Note that you may need a transimpedance amplifier IC to convert small photodiode currents into scalable voltages before the reflectance signal is presented to an external or MCU-integrated A/D converter.

Figure 3 – BPY62 detector (8° Half Angle)

I hope this very high-level overview has removed some of the "cloudiness" associated with turbidity measurement, and "clarified" another useful application for high power IR LEDs.

As always, feel free to send me your high-brightness LED questions, comments at **LightSpeed@Avnet.com**

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is Global Director of the Solid State Lighting and Advanced LED business unit of Avnet Electronics Marketing. An ardent advocate of energy efficient LED-based illumination, he has worked closely with LED manufacturers, advanced analog IC and secondary optics vendors since his first patent using LEDs was issued two decades ago. Avnet works with customers through their national team of illumination-focused sales engineers who are experienced in thermal, drive stage and optics design. Prior to his LED lighting focus, Cary was Avnet's technical director and managed Avnet's North American FAE team.

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