PbSe Infrared Detectors

It is easier to make a detector noise limited system than one might think

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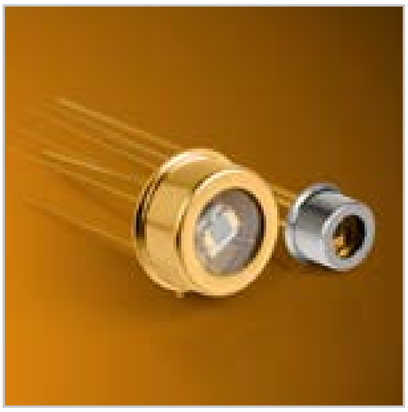
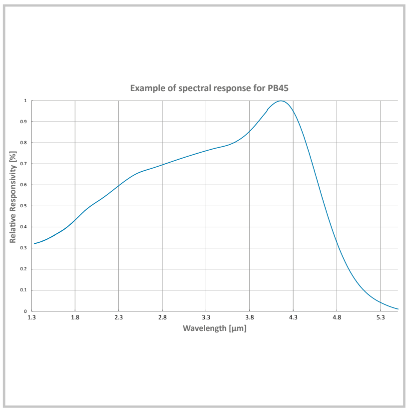


Instrument designers can achieve optimal operation of PbSe IR detectors by choosing the ideal bias voltage, optical chopping frequency, or a combination of the two. To explain how this is possible, first it is important to understand the basic operating concepts of Lead Selenide detectors.

Photoconductive PbSe detectors have a spectral response from 1 – 5.2 micrometers and is the detector of choice due to its high sensitivity and relatively low cost. These detectors operate on the principle that the conductivity of the material will increase as photons incident on the polycrystalline thin film promote electrons across its bandgap through electron/hole generation. Therefore, the detector resistance will change in response to varying amounts of incident photons. When the detector is connected in series to a load resistor and a bias voltage is applied, the detector response will change the current in the circuit. The voltage drop across the load resistor is used to measure the change in current.



Spectral Response for room temperature PbSe detectors

Since the PbSe detector resistance changes in response to incident photons and the resulting change in circuit current is how the incident energy is measured, the IR light must be chopped at a frequency, f. There is a mathematical relationship that can determine the detector responsivity (signal) when the chopping frequency, detector time constant at a particular operating temperature, and detector dark responsivity are known. Additionally, because PbSe detectors exhibit 1/f noise, the normalized signal to noise ratio, or D*(detectivity), can be determined.

So how can one adjust the bias voltage and chopping frequency to get optimum detector operation? The specific values are instrument and application dependent. Success has been found by many gas analysis, spectrometer, flame detection, and non-contact temperature measurement OEM designers when making their instruments detector noise limited instead of circuit noise limited. That is when true S/N (signal to noise) can be seen. The key is to understand that increasing bias voltage increases the signal in direct proportion and that decreasing the optical chopping frequency increases the detector noise level.

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It is also important to know that one must apply enough bias in order to raise the noise level above the Johnson noise level of the circuit yet high bias voltages are often not practical or safe in most instruments. Neither is operating at high chopping frequencies. Often, when lowering the chopping frequency a designer can also lower the bias voltage and still have the 1/f noise component be dominant. Therefore, adjusting the bias voltage or lowering the chopping frequency or a combination of both will be the sweet spot for operating a detector noise limited system.

Laser Components has a team of PbSe detector experts ready to work with instrument designers to develop custom specifications that include the ideal optical chopping frequency, bias voltage, and other potentially critical system parameters. Paying close attention to these details results in top performing instrumentation.

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