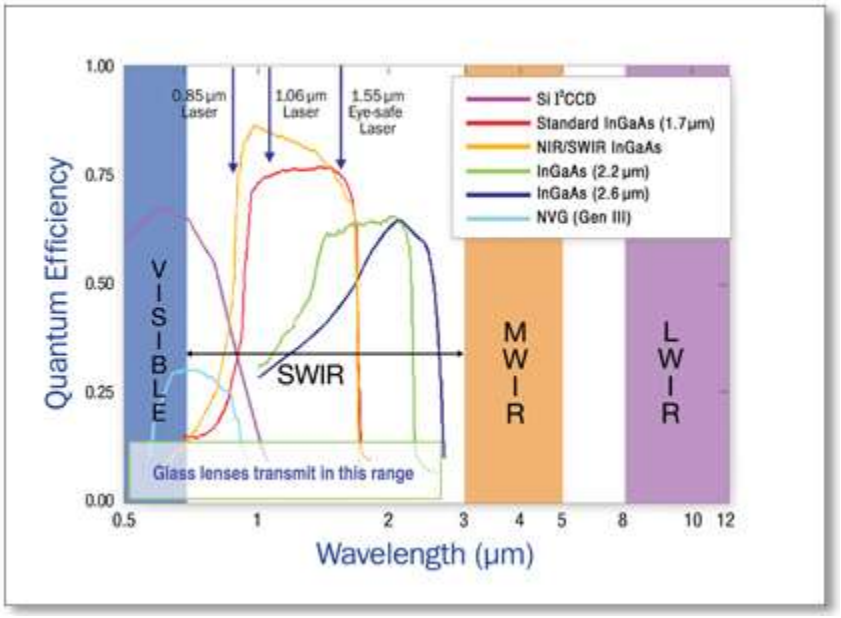
Why SWIR?

What is the Value of Shortwave Infrared?

Sensing in the shortwave infrared (SWIR) range (wavelengths from 0.9 to 1.7 microns) has only recently been made practical by the development of Indium Gallium Arsenide (InGaAs) sensors. Sensors Unlimited, Inc., part of UTC Aerospace Systems, is the pioneer in this technology and clear leader in advancing the capability of SWIR sensors. Founded in 1991 to create lattice-matched InGaAs structures, Sensors Unlimited, Inc. quickly grew as the telecom industry recognized the exceptional capabilities of this remarkable material.



Sensors Unlimited has continued to push InGaAs technology forward, today producing not just single point light sensing diodes, but InGaAs one-dimensional linear arrays and two-dimensional focal plane array cameras. But why use SWIR?

First, a basic fact: light in the SWIR band is not visible to the human eye. The visible spectrum extends from wavelengths of 0.4 microns (blue, nearly ultraviolet to the eye) to 0.7 microns (deep red). Wavelengths longer than visible wavelengths can only be seen by dedicated sensors, such as InGaAs. But, although light in the shortwave infrared region is not visible to the eye, this light interacts with objects in a similar manner as visible wavelengths. That is, SWIR light is reflective light; it bounces off of objects much like visible light. As a result of its reflective nature, SWIR light has shadows and contrast in its imagery. Images from an InGaAs camera are comparable to visible images in resolution and detail; however, SWIR images are not in color. This makes objects easily recognizeable and yields one of the tactical advantages of the SWIR, namely, object or individual identification.

What Makes InGaAs Useful?

That makes InGaAs interesting, but what makes it useful? Well, InGaAs sensors can be made extremely sensitive, literally counting individual photons. Thus, when built as focal plane arrays with thousands or millions of tiny point sensors, or sensor pixels, SWIR cameras will work in very dark conditions. Night vision goggles have been around for several decades and operate by sensing and amplifying reflected visible starlight, or other ambient light, in what are called image intensification (I-Squared) tubes. This technology has worked well for direct view night vision goggles. But when an image needs to be sent to a remote location (an intelligence center, for example), there is no practical method which does not introduce reliability and sensitivity limitations (e.g. I2CCD). Because all of SUI's SWIR sensors convert light to electrical signals, they are inherently suitable for standard storage or transmission techniques.

Using SWIR at night has another major advantage. An atmospheric phenomenon called night sky radiance emits five to seven times more illumination than starlight, nearly all of it in the SWIR wavelengths. So, with a SWIR camera and this night radiance - often called nightglow - we can "see" objects with great clarity on moonless nights and share these images across networks as no other imaging device can do. For more information on night vision, go to our Night Vision application page.

But aren't there other cameras that operate in the shortwave infrared range? Yes, sensors constructed from materials like mercury cadmium telluride (HgCdTe) or indium antimonide (InSb) can be very sensitive in the SWIR band. However, in order to increase their signal-to-noise ratio to usable levels, these cameras must be mechanically cooled, often to extremely low temperatures. In large military aircraft designed for surveillance and reconnaissance, cooling is not a problem since these platforms are designed with plenty of space and power to run mechanical cooling systems. In stark contrast, similar sensitivity can be achieved at room temperatures with a Sensors Unlimited InGaAs camera.

Essentially, InGaAs cameras can be small and use very little power, but give big results. InGaAs found early applications in the telecom industry because it is sensitive to the light used in long distance fiber optics communications, usually around 1550 nm.Sensors Unlimited's InGaAs diodes and arrays continue to be used in telecom, often in Optical Power Monitors that employ spectrometers operating in the SWIR band. Surprisingly, interesting capabilities have resulted from this combination. By using SWIR illumination like 1.55 micron lasers or LEDs, it is possible to covertly illuminate a scene that can be viewed only with SWIR cameras. So, imagine a military truck able to temporarily illuminate its path when nightglow is not available (for instance, a road under thick tree branches or in a tunnel) in order to safely navigate a route in hostile territory. SUI InGaAs cameras are of great value in such applications. And because such illuminators are eye safe, there are few restrictions on how they are used.

Detection Through Thermal Imagers

Thermal imagers are another class of camera with good detection abilities. Sensors Unlimited often recommends that such imagers are a good compliment to SWIR. While thermal imaging can detect the presence of a warm object against a cool background, a SWIR camera can actually identify what that object is. That's because thermal imagers do not provide the resolution and dynamic range of imaging possible with an InGaAs SWIR focal plane array. In the military world, the serious problem of determining whether a threatening vehicle is a civilian truck or a military tank is crucial. SWIR can help with this friend-or-foe determination.

CMOS and CCD imagers are excellent devices that continue to evolve to meet military needs. But such sensors are typically just daylight sensors. On the other hand, a single SWIR camera can be used for both day and night imaging. In an Unmanned Aerial Vehicle (UAV), for example, this single camera can operate over the full duration of typical long day/night mission profiles. Winner: SWIR.

Image Through Glass

Finally, one major benefit of SWIR imaging that is unmatched by other technologies is the ability to image through glass. Meaning, Sensors Unlimited's cameras can use conventional, cost-effective visible camera lenses for all but the most demanding applications. For SWIR cameras, special expensive lensing or environmentally hardened housings are mostly unnecessary - making them available for a wide variety of applications and industries. This ability also allows for the shortwave IR camera to be mounted inside a protective window, providing extra flexibilty when positioning the camera system on a potential platform.

So, Why SWIR?

- High sensitivity
- High resolution
- Seeing in the light of night glow or night sky radiance
- Day-to-night imaging
- Covert illumination
- Able to see covert lasers and beacons
- No cryogenic cooling required
- Conventional, low-cost visible spectrum lenses
- Small size
- Low power