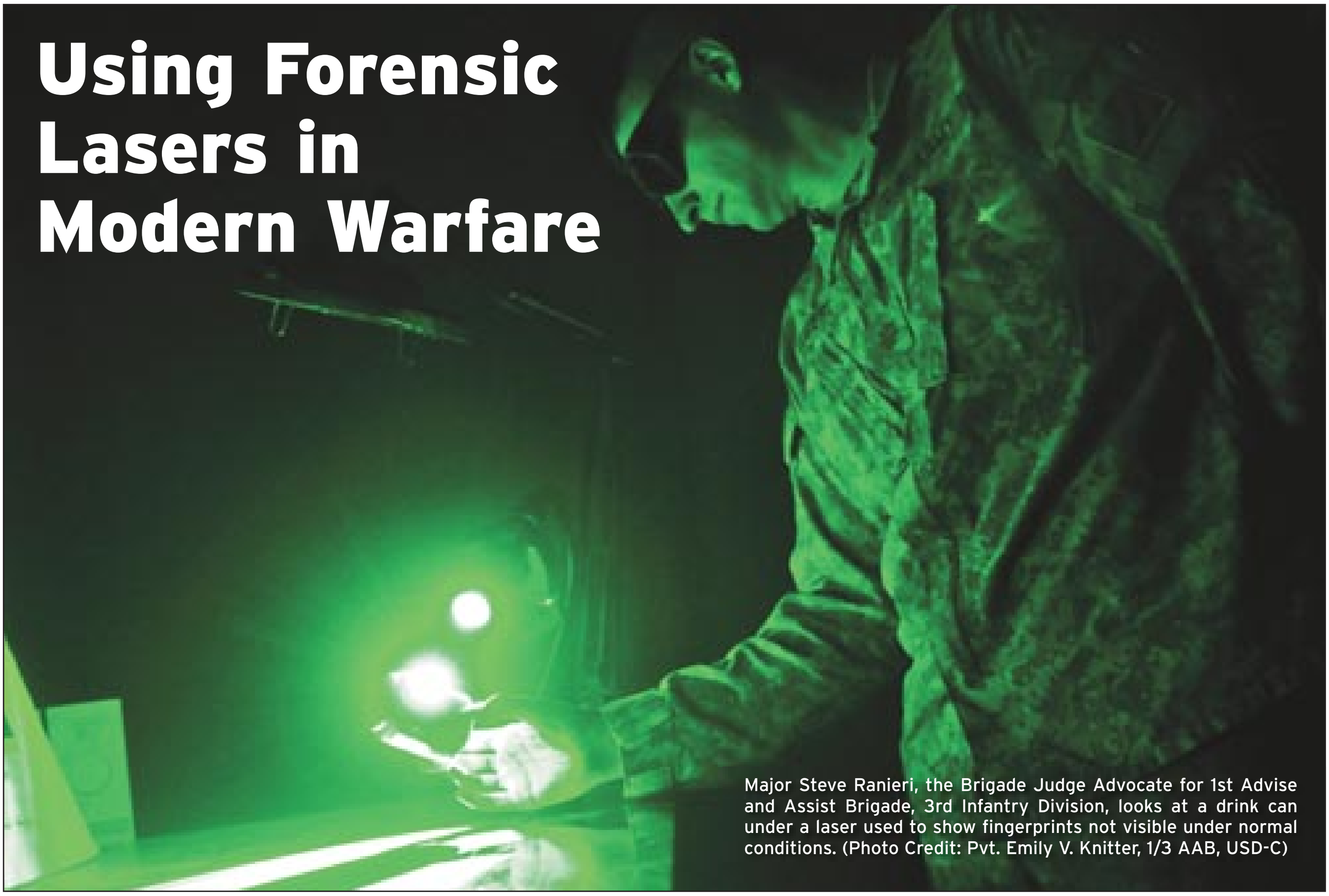
Using Forensic Lasers in Modern Warfare



Major Steve Ranieri, the Brigade Judge Advocate for 1st Advise and Assist Brigade, 3rd Infantry Division, looks at a drink can under a laser used to show fingerprints not visible under normal conditions. (Photo Credit: Pvt. Emily V. Knitter, 1/3 AAB, USD-C)

In the conflicts in Iraq and Afghanistan, the enemy's guerilla tactics have muddled the distinction between terrorism and warfare. To deal with the challenges of this new type of combat, the military has quietly built up impressive forensic capabilities, with technology more usually found in domestic crime labs than on the battlefield. Just as they have in numerous areas of weapons technology, lasers play a cutting-edge role in this work, which is performed on location, within mobile labs in Afghanistan, as well as in the US.

The main military use of forensic lasers is to find latent fingerprints on a variety of different substrates. This effort is targeted at tasks, such as identifying those who have handled an IED (improvised explosive device), and determining those responsible for its creation. This can be accomplished by examining the components of these devices either before or after explosion. Another reason for lifting prints is to establish the identity of individuals who may have handled a weapon in the commission of a crime, or to track the provenance of counterfeit documents.

Laser-Excited Fluorescence

Proven in non-military forensics, green lasers (532 nm wavelength) are workhorse tools, used primarily for locating and imaging latent fingerprints via laser-excited fluorescence. This can be accomplished on both porous and non-porous surfaces. Fluorescence occurs when a bright light, such as a laser, illuminates certain materials (such as sweat and finger oil), and some of the light is re-emitted at a longer wavelength. Because the laser illumination and fluorescence are different colors, optical filters can be used to separate them. Specifically, a filter which blocks the laser light but transmits the fluorescence significantly enhances the contrast of the print, allowing it to be viewed and photographed (Figure 1).

Sometimes a print can be imaged in this way with no chemical pre-treating. That is because many organic materials, including lipids and proteins, exhibit weak natural fluorescence, called inherent fluorescence. But, while high ambient temperatures in Afghanistan cause increased likelihood of sweating, thus yielding prints containing more bodily fluids, in most cases the substrates have to be treated with a fluorescent dye according to standard protocols used by forensic/CSI labs and domestic law enforcement groups.

In this protocol, the substrate is first exposed to superglue fumes, which preferentially bind to the lipids and other trace organics and inorganics in a print. The surface is then exposed to the highly fluorescent Rhodamine 6G dye, which clings persistently to the ethyl or methyl cyanoacrylate (superglue). As a result, when viewed through the wavelength selective glass filter, the print can be literally thousands of times brighter (Figure 2) than any scattered laser illumination light.

The Evolution of Forensic Lasers

Crime labs originally developed this application using blue (488 nm) and/or blue-green (514 nm) output from argon ion lasers. But these large, delicate, and power-hungry lasers required a 220-volt power supply and water cooling, making them impractical for field use. Because of these limitations, crime scenes were instead "swept" with an alternative light source (ALS) in order to excite fluorescence, even though the ALS usually delivered inferior results to a laser. In spite of its cryptic acronym, an ALS is actually no more than just a bright lamp whose output is passed through an optical filter, sometimes with fiber coupling to a handpiece.

The advent of compact visible lasers, based on diode-pumped, solid-state (DPSS) technology with green (532 nm) output, enabled the first portable laser applications. But these crystal-based lasers were often too expensive, and still not rugged enough for crime scene work, let alone field use by the military. The situation completely changed with the development of optically pumped semiconductor laser (OPSL) technology. This enabled the construction of highly compact green (and other wavelength) lasers, with power consumption low enough to even enable battery operation. And because OPSL technology can be readily made immune to shock and vibration, forensic lasers based on this technology provide the 24/7 rugged reliability needed for demanding field use, tough handling, and high-throughput screening.

A View from the Field

Chere S. Reynolds is a former civilian military contract employee who recently completed a third deployment to Afghanistan (two at Kandahar and one at Bagram) as a Latent Print Processing Technician. Reynolds explains the need for high throughput at these sites, "Most IEDs incorporate a lot of adhesive tape. For some cases, our lab often would have to process over 1000 pieces of tape, looking for latent prints on both the adhesive and non-adhesive side. Yet, sometimes we'd be allocated as little as 48 hours per case. We'd first perform an inherent exam of the tape or other evidence, that is, without using any chemical treatment to develop and reveal latent prints. We'd then most commonly do a standard dye and laser exam. During my first deployment in 2011, we switched from illuminating the dye using an ALS to using a green Optically Pumped Semiconductor Laser (OPSL). The number and quality of prints we obtained shot up dramatically with laser excitation."

The reasons for this difference are well documented. First, the laser has much higher monochromaticity (wavelength

(Continued on page 10)

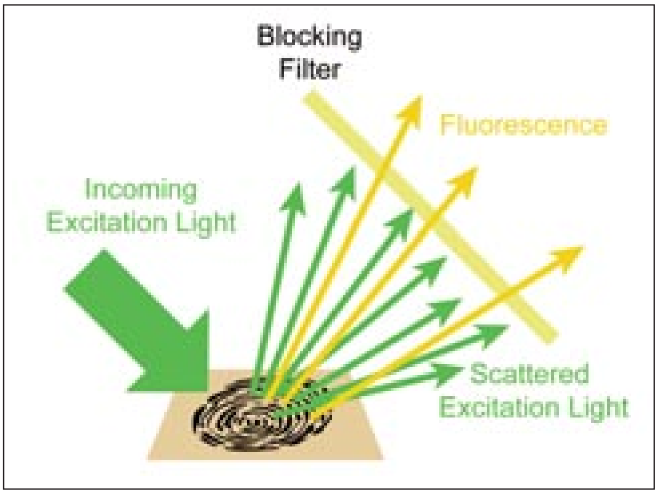


Figure 1. A filter which blocks the laser light but transmits the fluorescence significantly enhances the contrast of the print, allowing it to be viewed and photographed.

(Continued from page 7)

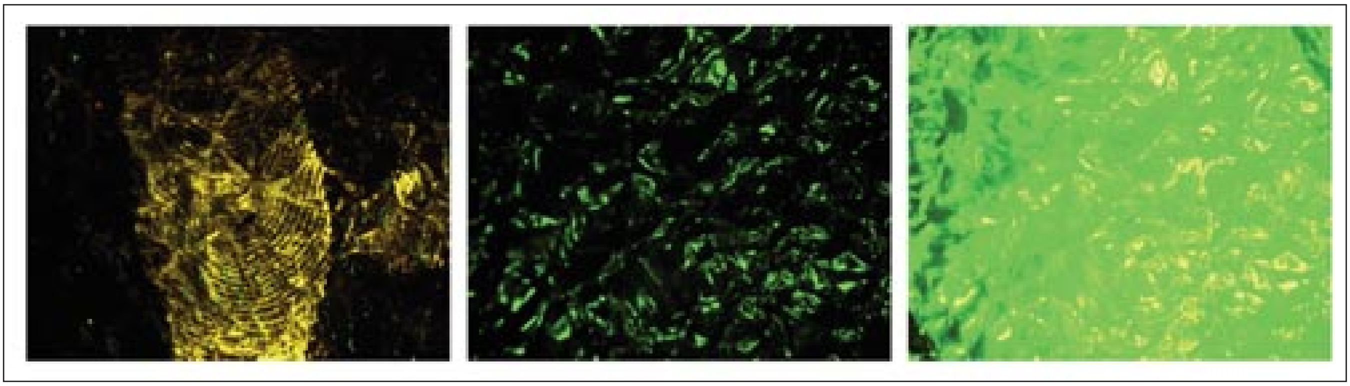
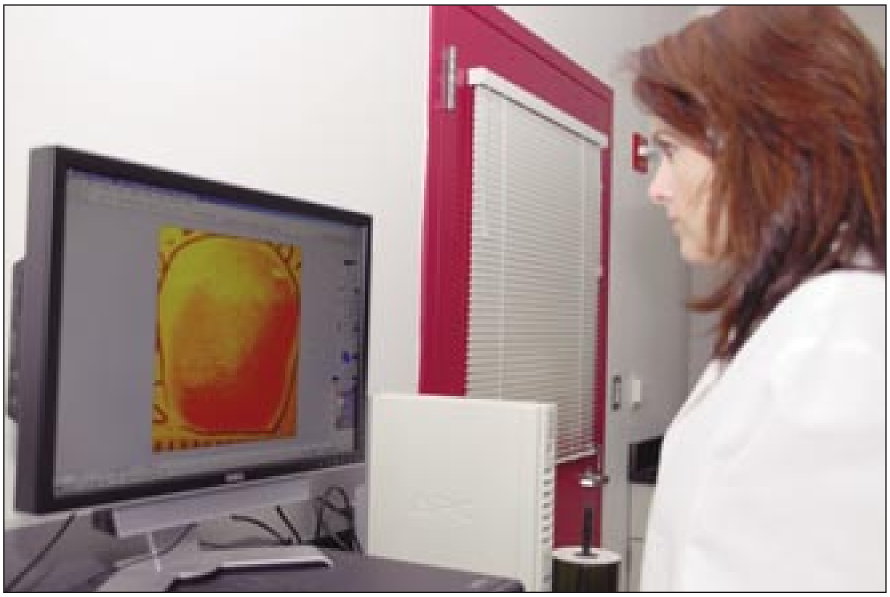


Figure 2. One of the advantages of green (532 nm) laser light is that it generates high fluorescence intensity. On this Rhodamine-dusted aluminum foil, this allows the camera aperture to be greatly reduced to obtain sufficient depth of focus for this highly contoured surface (left). This same dusted print could not be seen with an ALS (center), even with an extended exposure time with the ALS (right).



Forensic scientist Lisa Carson examines a fingerprint treated with Rhodamine and illuminated with a laser. The Rhodamine causes the print to fluoresce under the laser. (Photo Credit: Ms. Elizabeth Lorge (ARNEWS))

brightness) than an ALS. Second, it also has higher spatial brightness, making it easy to direct all of the laser's output into a small area, usually by means of a fiber optic connected handpiece. Together, these result in brighter fluorescence. Moreover, a laser also offers a time/speed advantage; it is ideal for single-sweep work, whereas optimum use of an ALS often requires multiple sweeps with different filter settings.

To deal with their high volume of work, the military now uses approximately twenty green lasers; these TracER laser systems are manufactured using Coherent's patented OPSL technology, and are supplied to the military by specialty US distributor Arrowhead Forensics. Some of these laser systems incorporate a rechargeable battery pack for field portability. The battery pack has the added advantage of making the laser immune to frequent power interruptions due to the lack of infrastructure in overseas power grids, such as in Afghanistan.

Rugged Reliability and Immunity to Vibrations

The semiconductor reliability of OPSLs has certainly been put to the test in this military work, particularly at the bases in Afghanistan. Reynolds explains that, "The mobile labs are pods based on standard 40 foot 'conex' transshipment containers, with bump-out sides. The outdoor temperature can vary from well below freezing to over 120°F. The lab heaters are hard to control, and the lab temperature could drop down below 40°F and then surge to the 80°F to 90°F range. And, because one of our labs was on a second story, the nearby landing and take-off of fighter jets caused major vibrational issues. Yet, we never had a laser head shift out of optimum alignment or fail in spite of all these very challenging operating conditions."

Summary

While lasers have certainly established their place in modern warfare, particularly in the areas of targeting, guidance, and countermeasures, they are also now quietly playing a key enabling role in a very different aspect of today's military conflicts. In particular, in an age when opposing forces often consist of irregulars and insurgents, rather than a clearly identified army, they can aid in positively identifying the enemy. Furthermore, as this work shows, these advanced lasers have proven the ability to perform this task under the most harsh and extreme conditions.

This article was written by Mark Keirstead, Coherent Inc. (Santa Clara, CA) and Brad Brown, Arrowhead Forensics (Lenexa, KS). For more information, visit ***http://info.hotims.com/49746-501***.