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Articles

Forensic Lasers Meet Unique Challenges in Military Applications in Afghanistan and Stateside

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Lasers reliably work 24/7 in dusty, hot conditions and high ambient vibrations, retrieving latent prints and other trace evidence from a massive case load, often with 1000+ objects to be scanned per case.

Many readers of this newsletter may be surprised to learn that the U.S. military has impressive forensic operational resources, in terms of both their technical capabilities and the massive scale of their work. In recent times, a large focus and scaled-up forensic operation has been supporting the work of troops in Afghanistan. This work is performed on location, within mobile labs in Afghanistan, as well as in the U.S. In both settings, military and civilian contract specialist technicians make extensive use of lasers, primarily to find latent impressions on a variety of different substrates.

The work is targeted at tasks such as determining who handled an IED (improvised explosive device) and to determine who was responsible for its creation. This can be accomplished by examining the components of these devices either before or after explosion. Another task is establishing the identity of the individual who may have handled a weapon in the commission of a crime, or tracking the provenance of counterfeit documents.

As for many non-military forensic labs and CSI professionals, green lasers (532 nm wavelength) are frontline, workhorse tools, used primarily for locating and imaging latent prints via fluorescence—on both porous and non-porous surfaces. Fluorescence occurs when a bright light, such as a laser, illuminates certain materials and some of the light is re-emitted at a different color (longer wavelength). The substrate is viewed and photographed through a wavelength selective filter which completely blocks the illumination wavelength but passes most of the fluorescent light. Many organic materials including lipids and proteins exhibit weak natural fluorescence, called inherent fluorescence, sometimes enabling direct detection using a laser or other light source. But, while high ambient temperatures in Afghanistan cause increased likelihood of sweating, and hence, 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.

Chere S. Reynolds is a former civilian military contract employee (a Latent Print Processing Technician) who recently completed three deployments to Afghanistan, as a LP Processing Tech. She 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, i.e., 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 a simple filtered lamp, called an alternate light source (ALS), to using a green laser. 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 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, resulting in brighter fluorescence—see figure 1. 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.

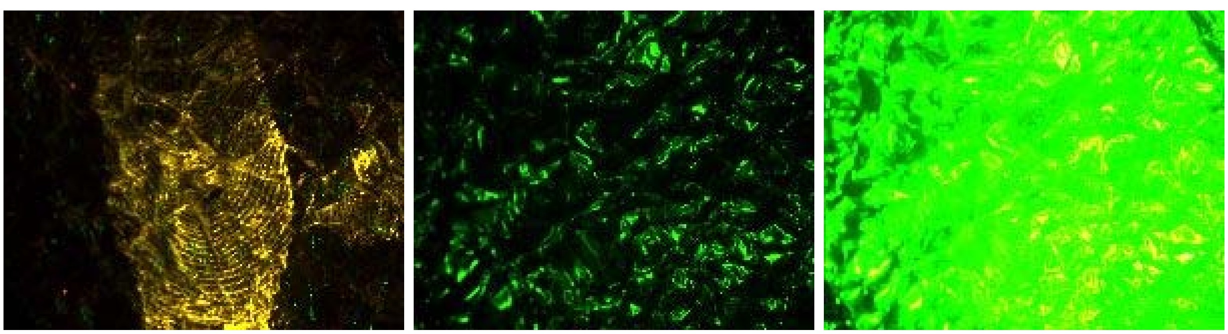

Figure 1. One of the advantages of green (532nm) laser light is that it generates high fluorescence intensity. On this Rhodamine-dusted aluminum foil, this allows the camera aperture to be greatly reduced to obtain sufficient depth of focus for this highly contoured surface (a). This same dusted print could not be seen with an ALS (b). Even with an extended exposure time with the ALS (c).

To deal with their high volume of work, the military now uses approximately twenty green lasers; these TracER lasers are manufactured by Coherent and are supplied to the military by specialty U.S. distributor Arrowhead Forensics. Some of these incorporate a rechargeable battery pack for field portability. Brad Brown of Arrowhead notes that in this particular application, “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 Afghanistan.”

Of course, lasers have long been used for forensic work, but for many years the limitations of available green laser technology prevented widespread adoption. Early green lasers were bulky, delicate, and unreliable; they also needed cooling water and a special 220 volt power supply precluding portable operation. Second generation solid state lasers based on crystal materials solved many of these issues, but their high cost and long-term stability issues were significant obstacles to universal acceptance. However, today's third generation solid state lasers rely on cost-effective, optically pumped semiconductor laser (OPSL) technology that eliminates all of the hurdles presented by earlier lasers. Specifically, these semiconductor lasers are compact, highly reliable, electrically efficient, and largely immune to shock and vibration. They are widely used throughout the U.S. by state and federal law enforcement groups, and have also been adopted for applications ranging from medical procedures to outdoor light shows and rock concerts.

This semiconductor reliability 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" trans-shipment 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 80-90°F range. And dust is everywhere. Plus vibration was surprisingly a potential issue; because one of our labs was on a second story, the nearby landing and take-off of fighter jets caused major vibrations of the lab. Yet we never had a laser head shift out of optimum alignment or fail in spite of all these very challenging operating conditions."

In conclusion, it is an unfortunate reality that the cutting edge instruments and tools which provide state of the art results are often limited in their utility because they are delicate, expensive, and require careful handling by a skilled operator. This was certainly the case for green forensic lasers for many years. But, the advent of rugged and reliable OPSL technology has completely changed this picture. As this work shows, advanced lasers can now perform flawlessly under the most harsh and hostile conditions, beyond anything the typical forensic or CSI professional is ever likely to subject their tools to here in the U.S.A.

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