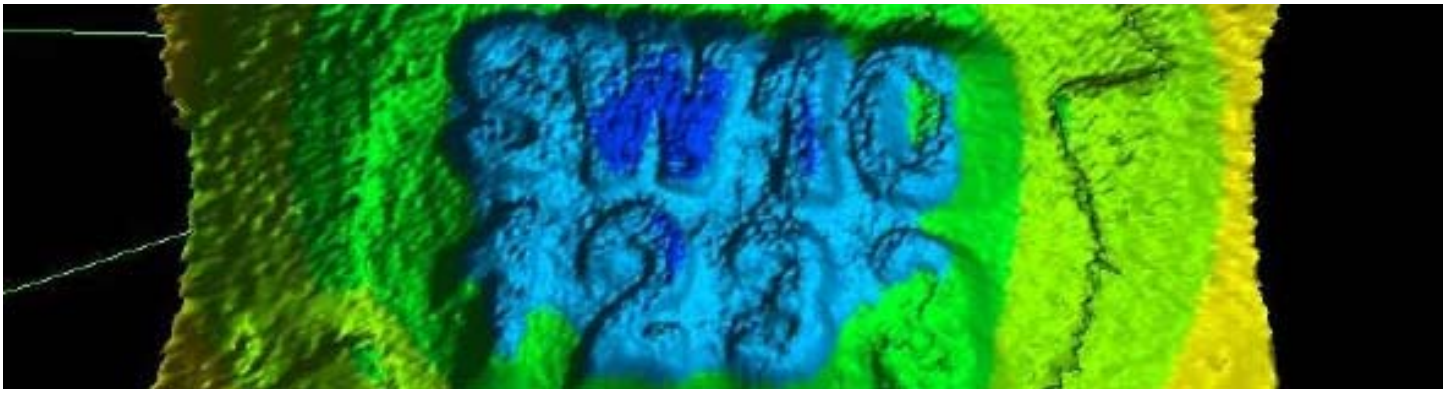
MICROSTAMPING TECHNOLOGY: PRECISE AND PROVEN

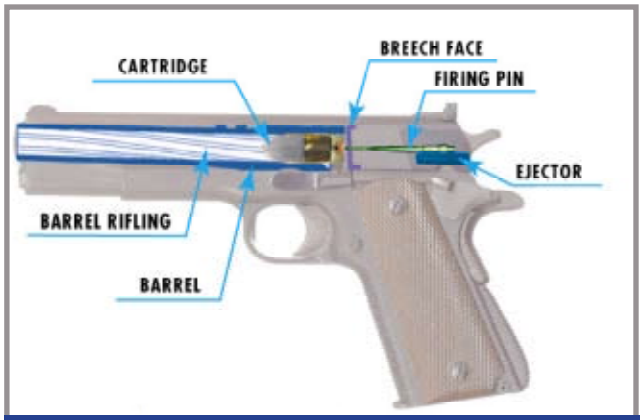


On October 13, 2007, California Governor Arnold Schwarzenegger made history by signing legislation that will give law enforcement officials in the Golden State unprecedented new tools to solve gun-related crimes. AB-1471, the "Crime Gun Identification Act of 2007," mandates manufacturer "microstamping" of all new models of semiautomatic handgun models sold in the state starting in 2010.

In his signing statement for AB-1471, Governor Schwarzenegger acknowledged that public safety is one of the most important roles of government. Following the governor's lead, policy makers in other states and the U.S. Congress are showing significant interest in implementing microstamping technology.

AN EVOLUTION IN BALLISTIC IDENTIFICATION

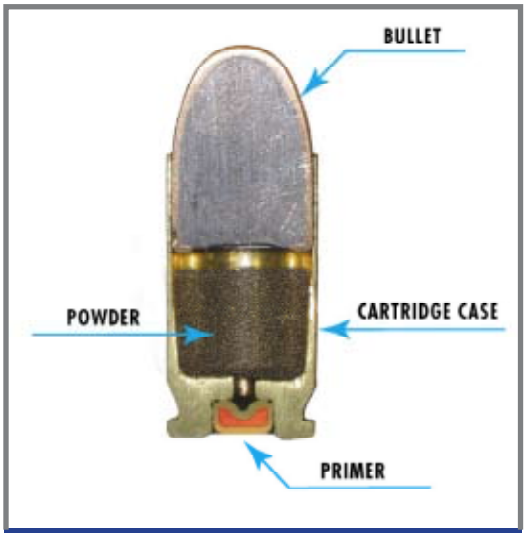
Microstamping technology utilizes lasers to make precise, microscopic engravings on the internal mechanisms of a gun, such as the breech face and firing pin. As the gun is fired, information identifying the make, model and serial number of the gun is stamped onto the cartridge as numbers and letters. The technology is designed to aid law enforcement officials investigating homicides and other crimes by allowing them to trace firearms through cartridge casings found at crime scenes. Tracing can provide a critical lead in investigations by identifying the original purchaser of a gun used in a crime.



Components of a Handgun

Microstamping was originally conceived in the 1990s by Todd Lizotte and Orest Ohar while developing micromachining and microidentification technologies for the electronics industry. After successfully applying the technology in the computer industry, the two began experimenting with firearms and discovered that they could etch up to 20 characters onto the tip of a handgun's firing pin. When they put the firing pin into a handgun, fired a round, and examined the cartridge case under a microscope, they found that the mark was readily visible on the cartridge case. Subsequent tests revealed that the mark remained clearly visible even after thousands of rounds were fired.

Lizotte and Ohar realized that microstamping had significant implications for the future of ballistics identification. They pioneered new methods to make microstamped markings tamper-resistant, in part by utilizing advanced metallurgical coatings and by adding redundant markings that can be identified even if the alphanumeric stamps on the firing pin tip are removed.



Components of a Cartridge

Microstamping represents a significant improvement over existing ballistic identification technology. Through the National Integrated Ballistic Information Network (NIBIN) program, the Bureau of Alcohol, Tobacco, Firearms and Explosives (ATF) currently deploys Integrated Ballistics Imaging System (IBIS) equipment and technology to state and local law enforcement agencies for use in comparing ballistic evidence found at crime scenes. IBIS uses imaging software to capture images of the unintentional markings on bullets and cartridge cases recovered at crime scenes and compare them to similar evidence from other crime scenes. These unintentional markings are produced by tool marks left on the firearm during the manufacturing process. For close to a century, trained firearms examiners have used these unintentional markings to positively identify cartridge cases fired by the same gun. By automating the process and narrowing the data only to likely matches, NIBIN allows law enforcement agencies to discover links between crime scenes that might not otherwise be apparent.

NIBIN has proven its value as a law enforcement tool, but even at its fullest potential, it has a significant limitation: it only contains images of ballistic fingerprints from past crime scenes. As a result, NIBIN cannot lead investigators directly to a specific firearm that produced a ballistic fingerprint unless that weapon is eventually recovered.

Microstamping is not subject to this limitation. Because the technology stamps the identifying characteristics of the firearm onto every cartridge ejected from the gun, investigators would not need to recover the crime gun itself to secure its serial number and initiate a trace request. The crime-solving potential is enormous.

CLOSING CASES, DETERRING CRIMINALS

The national "clearance" rate for homicide cases in 2005 was 62%[1] —there were approximately 3,235 unsolved gun homicides that year.[2] In the future, a higher percentage of cases could be closed if investigators could identify crime guns solely from cartridge cases collected at crime scenes. The city of Boston is a prime example. In 2006, there were a total of 1,301 crimes involving a shooting in the city. Yet at 636 of these crime scenes, only shell casings—and not the crime gun(s) itself—were recovered.[3]

The technology could also help to deter "straw purchases" of firearms through licensed dealers, a common trafficking method. In a straw purchase, a prohibited purchaser recruits an individual(s) with a clean criminal record to pass a background check and purchase firearms for him/her. A straw purchase is a federal felony offense for both the straw purchaser and the ultimate possessor of the firearms. Straw purchasers would be less likely to act in this capacity if they believed a gun could be successfully traced back to them after being used in a crime.

IMPROVING DATA

Evidence suggests that microstamping would result in thousands of additional successful gun traces each year. Coupled with existing systems like NIBIN and IBIS, it would serve to exponentially increase the crime-solving capabilities of law enforcement officers across the nation. Moreover, microstamping would not necessitate the creation of any new database of gun owners or ballistics information. The technology would stand up on the existing trace database and add to the information already housed there.

Microstamping will also help law enforcement better understand the flow of illegally trafficked firearms by creating a stronger chain of accountability from the initial purchase onward. Law enforcement have made it clear that in today's environment "accurate and timely intelligence or information is absolutely essential in

effectively responding to any problem or crisis."[4] Microstamping would provide another data point to map trends in firearms trafficking—within a region, county, city, or even a section of a city. By identifying traffickers and putting them behind bars, authorities can curb the flow of illegal guns to criminals on America's streets.

STANDING UP TO THE TEST

In recent years, microstamping technology has gone through numerous tests and studies to determine its feasibility and durability. Some critics have cast doubt on the technology—suggesting that it cannot withstand wear and tear under the violent conditions that exist within the chamber of a firearm. Microstamping, however, has been rigorously tested under varying conditions and has disproved all such claims.

Studies have been conducted by the following individuals:

Lucien Haag: Haag is a widely respected forensic scientist who was interested in testing the durability of microstamps and subsequently conducted his own tests. He acquired marked firing pins from Lizotte and tested them using guns that he thought were most likely to challenge the technology. His results indicated that marked firing pins continue to leave clear impressions on cartridges even after hundreds of rounds, and even in guns that operate under extremely high pressure.[5] In an abstract presented before the 2004 conference of the Association of Firearm and Tool Mark Examiners (AFTE), Haag mentioned his earlier doubts about the technology's durability, but noted, "The manufacturer was contacted and subsequently embossed the tips of firing pins from several machine guns, a submachine gun, and a Glock pistol for a variety of tests by this examiner … The various characters on all these firing pins were easily readable in all types of primers tested and after hundreds of shots."[6]

George Krivosta: Krivosta is a forensics examiner who conducted a microstamping test whose results were published in the Winter 2006 edition of the AFTE Journal. In the article, Krivosta questioned the decipherability of microstamped markings, criticized the durability of the engraved firing pins he tested, and suggested that the countermeasures that Lizotte had developed to defeat the intentional defacement of microstamped firing pins were insufficient. Krivosta concluded that "implementing [microstamping] will be much more complicated than burning a serial number on a few parts and dropping them into firearms being manufactured."[7]

> **"...Forensic testing of ammunition used in a crime is the most effective way of tracing criminal activity."**
> *- Governor Arnold Schwarzenegger*

A closer examination of his study, however, reveals serious flaws in Krivosta's methodology:

- Krivosta operated with the false assumption that microstamping would make expertly trained ballistics examiners obsolete. According to Krivosta, the average police officer should have the ability to examine and decipher microstamped markings at a crime scene. Such a claim was never made by either Lizotte or Ohar.[8] As a result, Krivosta did not employ the technology that one would find in any standard ballistics lab in examining microstamped markings during his testing.

- In his test, Krivosta used old firearms and non-optimized firing pins from an early research and development effort in Rhode Island. The technology Krivosta tested does not represent the mature microstamping technology that is currently available.

- Some of Krivosta's self-imposed restrictions on the study were unreasonable. Krivosta required the successful transfer of seven of eight characters in order for a microstamped impression to be deemed "satisfactory." In a real world investigation, however, even if only six characters could be read by a ballistics investigator, that would narrow the field to just five possible firearms!

Michael Beddow: While AB-1471 was being debated in the California legislature, Beddow, a graduate student at UC Davis, conducted a study on microstamping for a research paper entitled "What Laser Machining Technology Adds to Firearm Forensics: How Viable are Micro-Marked Firing Pins as Evidence?" In a subsequent university press release dated May 3, 2007, Beddow stated that microstamping "does not work well for all guns and ammunition tested" and required "more testing…to determine the costs and feasibility of a statewide program."

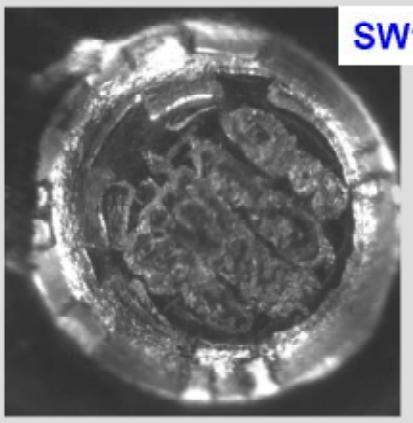
Assemblyman Mike Feuer, the sponsor of AB-1471, received a letter from UC Davis Chancellor Larry N. Vanderhoef shortly thereafter in which Vanderhoef apologized for the university's press release. In the letter, Vanderhoef "set the record straight" by pointing out that: a) Beddow's study had not been peer reviewed; b) it was not commissioned by the state legislature as the release claimed, and c) it drew false conclusions in regards to AB-1471.

The "false conclusions" cited by Vanderhoef referred to several serious flaws in the Beddow study:

- The study utilized vintage firearms that had never been considered for testing previously because of their model age (10-50+ years) and mechanical condition. They were acquired from the California Department of Justice firearm library. AB-1471, of course, applied only to new models of semiautomatic handguns.

- Beddow used non-optimized firing pins in his study, even though Lizotte offered him optimized firing pins—an offer Beddow declined due to budget constraints.

- Beddow used Optical Microscopy to examine microstamped markings in his study and had difficulty reading some of the impressions left by the technology. Many ballistics labs (including the lab at UC Davis), however, have access to a superior technology known as Scanning Electron Microscopy (SEM), which provides greater resolution and magnification. Lizotte later showed that questionably marked cartridges, similar to the ones fired in Beddow's test, were easily decipherable when using SEM techniques.



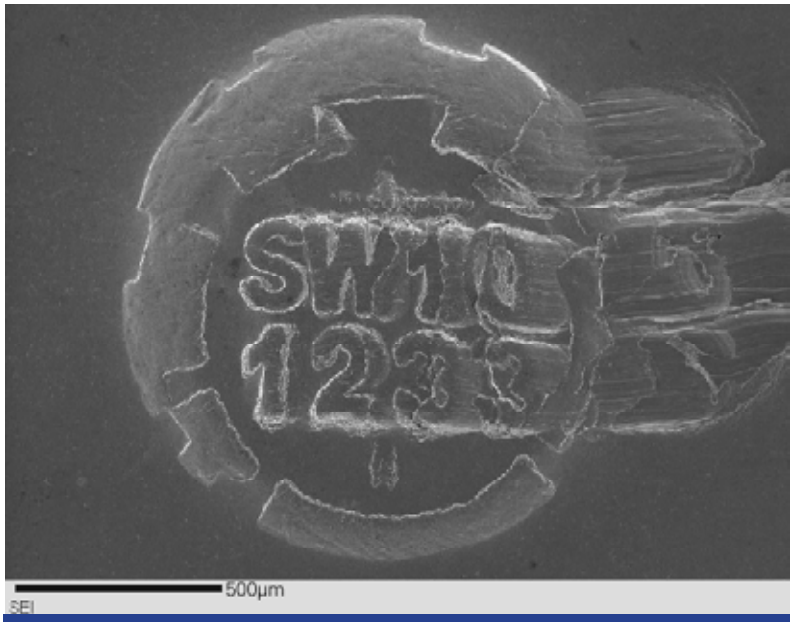
Optical Microscopy Stereo with Polarization (Marked Illegible) UC David Method

SEM Microscopy (Mark legible and decipherable)

SEM Backscatter Microscopy (Mark legible and decipherable)

The multi-hit cartridge on the left was deemed illegible by Beddow in his test. Using Scanning Electron Microscopy, Lizotte was able to clearly decipher multi-hit markings on cartridges.

Todd Lizotte: Immediately after the release of the Beddow study, microstamping co-inventor Lizotte conducted his own test in May 2007 to demonstrate the endurance and durability of the technology. In a stress test, Lizotte fired over 2,500 rounds from a Smith and Wesson .40 caliber semiautomatic handgun that had been outfitted with microstamping technology. The test employed fully optimized firing pins that were designed to work with that specific model of firearm. Lizotte used five different brands of ammunition.



The 2,501st round from Lizotte's test of microstamping shows clear markings on this double-hit cartridge using Scanning Electron Microscopy

Microstamped markings from the firing pin were transferred successfully, with all eight digits legible 97% of the time using both Optical Microscopy and Scanning Electron Microscopy. Additionally, breech face markings transferred to cartridge casings 96% of the time. This data included multi-hit primers, which are a result of rapid firing.[9] Between firing pin and breech face markings, all eight digits were identifiable in all cases.

GUN LOBBY MYTHS

In addition to drawing misleading conclusions from existing studies on microstamping, the gun lobby has circulated a number of other myths in an attempt to discredit the technology. Below are some of their more common arguments, which are easily refuted with facts about microstamping:

Criticism: Law enforcement doesn't support microstamping technology.

Response: The recent passage of microstamping legislation in California revealed that the technology enjoys widespread support among law enforcement. AB-1471 garnered the support of 65 police chiefs and sheriffs across California. The bill was also endorsed by the California Police Chiefs Association and the Peace Officers Research Association of California (PORAC), the largest state-wide public safety association in the country.

Criticism: Microstamping technology can be easily defeated by criminals with household tools.

Response: Microstamp-equipped weapons have several "counter measures" to prevent tampering by common criminals. These include redundant gear and radial marks on the firing pin, as well as marks on the breech face of the firearm. Various technologies exist today to harden firearm surfaces that carry microstamped information. The gun industry could choose to implement such technologies. Previous history, however, shows that it may not be necessary. Criminals do not typically alter guns that are used in crime. Furthermore, the redundant markings on the breech face are difficult to access, and require lab-quality microscopy to ensure they have been removed successfully.

An individual would need intimate knowledge of firearms and microstamping, plus the appropriate tools, in order to render the technology ineffective. These tools are certainly not "household items," nor would the common street criminal be expected to have the knowledge necessary to defeat the technology.

Criticism: Criminals will "seed" crime scenes with stolen cartridges from firing ranges to throw off investigators.

Response: Theoretically, there is nothing to prevent criminals from using this tactic *now*, in order to discourage potential ballistic matches through NIBIN. Nonetheless, reports of such "seeding" occurring are extremely rare at best. In the urgency under which crimes are committed, most criminals fail to do things as simple as wearing gloves to hide fingerprints. Few offenders ever have the time or presence of mind to "dress" a crime scene following the commission of a violent crime.

One can also imagine the scene at a shooting range as criminals or gang members wander around and gather spent cartridge cases in bags. Conspicuous? One would certainly think so, and Americans should expect the owners of such ranges to engage in more responsible business practices.

Criticism: Microstamping would lead to astronomical increases in the price of handguns, costing $200 per gun or more.

Response: The developers of microstamping have testified that it would cost manufacturers between $0.50 and $1.00 per handgun to incorporate the technology. Laser Light Technologies, Inc. (LLTI) corroborated this in a September 2007 letter to Assemblyman Mike Feuer, the sponsor of AB-1471. LLTI noted that "even in the worst case scenario" the price per handgun would range between $0.50 and $3.00. LLTI concluded: "The laser process as transferred to LLTI by the microstamping inventors is clear-cut and when coupled with appropriate fixtures, the task of processing the firearm components will be both uncomplicated and cost effective."

Criticism: Microstamped cartridges could not be recycled because they could implicate innocent individuals for crimes they did not commit.

> **"The Los Angeles County Sheriff's Department Homicide Bureau has hundreds of unsolved cases where the only evidence left at the scene of the crime were expended bullet casings. If these casings had imprinted information on them from the firearm, our investigators would have an exceptional chance of solving these heinous crimes."**
> *- Los Angeles Sheriff Lee Baca*

Response: Trained ballistics examiners can easily identify between new and recycled cartridges. Differentiating between the two is a normal part of an examiner's responsibilities when investigating a gun crime. There is a standardized procedure for identifying the characteristics of a recycled cartridge, which include the orientation of ballistics markings, the use of reload primers, and mismatched bullets/projectiles and powder residue. This process would not change if microstamping were implemented; nor would any special requirements be necessary.

Criticism: Microstamping is a sole-source technology that would create a government-sanctioned monopoly for a single company.

Response: In reality, the patent holders of the technology, Todd Lizotte and Orest Ohar, have announced that a royalty-free license for microstamping will be provided for semiautomatic handguns sold for civilian use over the entire United States and its territories. This offer was formalized in a June 15, 2007, press release, which confirmed that there will be "no sole source" for microstamping technology and that the free "license will provide the firearm industry a variety of options for selecting pre-qualified equipment suppliers and job-shop services or they will have the option of building their own equipment or use [sic] existing equipment to perform the microstamping process."

Criticism: Microstamping would be ineffective because most criminals purchase their guns illegally.

Response: Almost all crime guns are originally purchased through a retail outlet (in many cases, legally). The firearms tracing system and tools like microstamping are designed to identify how guns make their way from that first purchase to a crime scene. Once law enforcement officials have identified the first purchaser of a crime gun, they have a substantial lead to enhance an investigation.

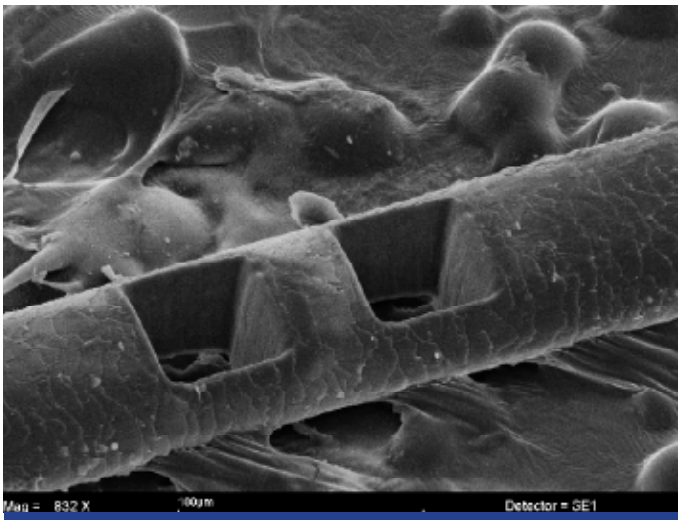
Criticism: Microstamped markings would be altered by residue produced from the normal operation of the firearm and/or by owners cleaning and caring for their firearms.

Response: Microstamping technology is designed to resist even deliberate tampering. The normal operation of a firearm would not adversely affect the markings. The structures created by the microstamping process are much harder than the surfaces they will be in contact with, eliminating the possibility of them wearing down.[10]

Additionally, crimes guns are frequently recovered with little wear and tear on them. A 2000 ATF study found that semiautomatic handguns have the shortest median "time-to-crime" of any firearm type, 4.5 years.[11] This marks the length of time from a firearm's first retail sale to its recovery by law enforcement as a crime gun. Joe Vince, a former Chief of ATF's Crime Gun Analysis Branch, has noted that crime guns are frequently recovered with fewer than 20 rounds fired.[12] In a 2007 test, Todd Lizotte fired thousands of rounds from a semiautomatic handgun equipped with microstamping technology and still demonstrated near perfect transfer rates.

Criticism: Microstamping technology has not been tested or studied "in the real world."

Response: *See previous section,* "**Standing Up to the Test.**"



The technology used in microstamping is so precise that it can make holes in a human hair.

A TECHNOLOGY WHOSE TIME HAS COME

Across the United States, countless victims and survivors of violent crimes are unable to obtain justice because there is insufficient evidence in their cases to identify and convict the perpetrator(s). During the critical initial hours of an investigation, too many crime scenes fail to yield valuable clues that can break open, or even launch, a successful investigation.

Microstamping promises to remedy this problem and revolutionize gun crime investigation. No longer will law enforcement need to wait to recover a crime gun. When microstamping is fully employed, many more cartridges found at a crime scene will contain valuable information that can lead police directly to a shooter's door.

America is a country that prides itself on developing new technology and using that technology to better the lives of its citizens. We have cured diseases, invented platforms to communicate instantly on a global level, and even touched the stars. Another historic opportunity is now at hand. Microstamping will provide law enforcement with new tools to solve gun crimes, put dangerous individuals behind bars, and create safer neighborhoods for *all* Americans.

ENDNOTES

1. Department of Justice, Bureau of Justice Statistics, "Homicide trends in the United States," 2005, http://www.ojp.usdoj.gov/bjs/homicide/cleared.htm
2. Department of Justice, Bureau of Justice Statistics, Data Online, "Reported Crime in the United States—Total," 2005, http://bjsdata.ojp.usdoj.gov/dataonline/Search/Crime/State/statebystaterun.cfm?stateid=52
3. Boston Police Department
4. Los Angeles Police Department, COMPSTAT Fact Sheet, http://www.lapdonline.org/crime_maps_and_compstat/content_basic_view/6363
5. Telephone interview with Lucien Haag, February 5, 2004
6. Haag, Lucien, "Ballistic ID Tagging—A Further Look," abstract presented before the 2004 conference of the Association of Firearm and Tool Mark Examiners, Vancouver, British Columbia
7. Krivosta, George G., "NanoTag Markings from Another Perspective," *AFTE Journal*, Volume 38, Number 1, Winter 2006, pp. 41-47
8. Lizotte and Ohar only suggested that in the *future* portable microscopy tools might be available to deploy at a crime scene.
9. All semiautomatic firearms induce oscillations and mechanical instabilities when pushed to the edge of their mechanical performance envelope. Firing events such as high frequency trigger pulls (also known as double-taps and triple-taps) induce firing pin vibrations that can delay the pin's retraction. The results can be seen as pin smearing and multiple-pin impressions on one cartridge. These cartridges can be difficult to decipher using standard optical microscopy techniques.
10. Even firing pin smearing during cartridge ejection, the most common instability during typical operation of semiautomatic firearms, does not wear away or deform the microstamped characters.
11. Department of Justice, Bureau of Alcohol, Tobacco and Firearms, "Crime Gun Trace Reports (2000): National Report," July 2002, p. 32, http://www.atf.gov/firearms/ycgii/2000/
12. *New York Times*, "Sniper Case Fuels a Debate Over Firearm Fingerprinting," October 18, 2002, http://query.nytimes.com/gst/fullpage.html?res=9C02E0DE133DF93BA25753C1A9649C8B63&n=Top/Reference/Times%20Topics/Subjects/I/Identification%20Devices

GLOSSARY OF TERMS

Ballistic fingerprint: A set of unique, reproducible markings left on each fired bullet and cartridge case by the firearm from which the bullet or cartridge case was fired.

Ballistic identification: The use of a ballistic fingerprint to identify the specific, individual firearm used to fire a given bullet or cartridge case.

Barrel: The tube on a firearm through which a bullet is propelled when a cartridge is fired.

Breech face: The flat, vertical surface that forms the rear of the firing chamber of a firearm.

Breech mark: A microscopic mark left on the base of a fired cartridge case by the surface of the breech face. Breech marks are most readily visible on the surface of the primer.

Bullet: The component of a cartridge, usually made of lead, that exits the firearm through the barrel when the cartridge is fired. Some lead bullets are "jacketed" with a layer of copper alloy or other metal.

Cartridge: A unit of firearm ammunition containing four components: primer, powder, bullet and cartridge case.

Cartridge case: The component of firearm ammunition, usually made of brass, that holds the primer, powder and bullet.

Ejector: On a semiautomatic firearm, a stationary metal bar or block that forces a fired cartridge case to eject from the firearm.

Ejector mark: An impression, usually visible to the naked eye, left on the base of a fired cartridge case by the collision between the cartridge case and the ejector. Microscopic details of an ejector mark are part of a firearm's ballistic fingerprint.

Firing pin: A narrow rod which, when released by pulling the trigger, springs forward and strikes the primer of a chambered cartridge, causing the cartridge to discharge.

Firing pin impression: An impression, visible to the naked eye, left on the primer of a fired cartridge by the firing pin. Microscopic details of a firing pin impression are part of a firearm's ballistic fingerprint.

IBIS: A computerized digital imaging system that captures and compares digital photographs of fired bullets and cartridge cases. IBIS stands for "Integrated Ballistic Identification System."

Magazine: A spring-loaded ammunition storage and feeding device that attaches to a firearm. A magazine can be detachable or fixed (i.e., non-detachable).

Metallurgical Coatings: Metal coatings deposited onto a surface by means of evaporation, sputtering or plating.

Metallurgical Lighting: Microscope lighting which uses various polarization techniques and interference contrast methods to enhance the edge image quality of microstructures to display detail that is otherwise unseen.

Microidentification: Process technology that produces identifying markings in order to prevent theft or tampering. Microidentification is utilized in the computer industry to safeguard against the counterfeiting of integrated circuits and commercial products such as toys and handbags.

Micromachining: A process method that utilizes lasers, reactive ion etching or chemical etching to allow the removal of microscopic amounts of material to form very precise and small parts. The process is used to make ink nozzles in inkjet printers.

Microstamp: A microscopic array of characters etched into the interior surfaces of a firearm during manufacturing, which transfers the characters to a cartridge case when the cartridge is discharged.

NIBIN: National Integrated Ballistic Information Network, operated by the Bureau of Alcohol, Tobacco, Firearms and Explosives and the Federal Bureau of Investigation. NIBIN uses the IBIS system to capture and compare ballistic fingerprints from cartridge cases and bullets recovered at crime scenes.

Powder: The component of firearm ammunition that ignites and burns when a cartridge is fired, releasing a tremendous amount of rapidly expanding gas that propels the bullet along the barrel.

Primer: A percussion-sensitive chemical mixture contained in the base of a cartridge. The primer explodes when struck by the firing pin, igniting the powder.

Rifling: A spiraling pattern of grooves on the interior surface of the barrel of most firearms, designed to cause the bullet to spin as it moves down the barrel.

Scanning Electron Microscopy: Scanning Electron Microscopy (SEM) is a magnification process that uses an electron gun to bombard an object with electrons. As this is occurring, a detector or grid picks up signals from the object in order to generate a three-dimensional picture of up to 30,000x magnification. The Backscatter Method of the technology uses the same equipment and process as traditional SEM, but examines electrons that are reflected off of the object in a specific direction to form a picture. This method differentiates between different elements such as iron or silver to create highly contrasted and clear images at 30,000x magnification.

Tracing: An investigative technique using existing records to identify the first retail purchaser of a firearm that was recovered in connection with a criminal investigation.