A170 An Improved Vacuum Casting Method for the Replication of Reference Bullets

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After attending this presentation, attendees will understand the application of vacuum casting to produce high-quality polymer replications of bullets, materials used, process steps and improvements, and comparisons of microscopy images and topography measurements.

This presentation will impact the forensic science community by providing a tool for forensic examiners to replicate ballistic evidence, such as tool marks generated by a firearm on a bullet or cartridge case. There are many instances where the transfer of ballistic evidence from one laboratory to another would be beneficial, e.g., in solving "cold cases," obtaining another assessment, or when there are suspected links in violent crimes.

The National Institute of Standards and Technology (NIST) developed an improved vacuum-casting replication method based on earlier work at the Bundeskriminalamt in Germany.[1] The replication process will be used to replenish the supply of NIST Standard Reference Material (SRM) 2460 bullets. The key property of the SRM bullets is the similarity of the striated markings on each bullet, enabling comparisons and quality control of measurement results obtained at different sites. The reference bullets were originally manufactured using a highly-repeatable, but expensive, diamond turning process. Extensive testing showed that polymer replication through vacuum casting is a viable and cost-effective alternative. The NIST Standard bullets are also well defined, and therefore allowed the validation of the polymer replication process through quantitative measurements and statistical methods.

The two-step process through which a replica polymer bullet is made is described. A negative mold of the bullet is first made using silicone, after which a positive replica bullet is made using polyurethane. The specific vacuum-casting techniques discussed are critical in forming clean replica bullets, free of micro-bubbles and contamination. Both qualitative and quantitative comparisons of the replicas with the original bullets are presented. The comparisons are based on conventional optical bright field microscopy images and measurements of the surface topography using confocal microscopy and surface profilometry.

Durability is a key requirement of reference samples. Since polyurethane plastics are not as hard as metal bullets, there is the potential for degradation of the replicas due to aging, environmental factors (temperature, humidity), abrasion, and contaminants. The results of several controlled experiments to address these concerns are presented.

High-quality replication enables sharing of ballistic information when the actual transfer of the physical evidence is not possible, either due to logistics, chain of custody issues, or simply because the evidence is too valuable to ship. Replicates can make measurements possible that cannot be performed on the original samples. Replication also enables the dissemination of virtually identical reference samples or proficiency testing sets to improve quality control and training.

Reference:

[1]A. Koch, J. Katterwe, Castings of Complex Stereometric Samples for Proficiency Tests in Firearm and Tool Mark Examinations, AFTE Journal, vol. 39 (4), 2007

Bullet Replication, Silicone Molding, Polyurethane Casting

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