



A106 Reflection Confocal Microscope Systems in the Forensic Laboratory — Problems Encountered in Bullet and Cartridge Case Examinations

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After attending this presentation, attendees will better understand the factors which define the capabilities and limitations of confocal microscopy in the forensic examination of bullets and cartridge cases. They will also understand how to select confocal instruments to fit their needs and the important factors in setting up those instruments for optimal use in the laboratory.

This presentation will impact the forensic science community by helping practitioners select and use incident light confocal microscopes for firearms examinations in the laboratory. Consequently, it should help in decision-making about the purchase of instruments and avoid the waste of limited resources as a result of improperly choosing equipment or using non-ideal settings of the instruments.

In December of 2009, funding was received to develop incident light confocal microscopy as a means determine surface topography of fired bullets and cartridge cases. Attempts have been made to determine to what extent impression markings as revealed by confocal microscopy can be used to individualize firearms and whether they can be interpreted in the same way as random striation markings on fired bullets and cartridge cases. Unexpected and challenging issues were encountered early in the work with confocal imaging on curved surfaces such as bullets and cartridge case firing pin impressions. Consequently, it became necessary to evaluate and, if possible, solve these problems before further work could continue. Theoretical issues, instruments, and optimal settings necessary to optimize confocal microscopy for the forensic examination of curved surfaces have been studied. The issues encountered, the scanning mechanisms and conditions determined to be optimal, and the instruments evaluated and ultimately selected for further research are reported here.

Based upon prior work, proposals were submitted to NIJ for funding to develop applications of confocal microscopy for firearms evidence examination. It was believed that the technique showed very significant promise in the forensic laboratory. Early in the research it was found that noise and the consequent lower quality of feature height measurement was directly related to the angle of the surface to the optic axis, and to other factors of instrument design. Evaluation of the instrument design element proved difficult due to limited information available from the manufacturers. However, both theoretical considerations and experimental results demonstrated the importance of numerical aperture and lens design on the quality of data obtained. It was determined that optimal magnification at the imaging plane is based on the consideration of both the maximum resolution available and the desired magnification (and resolution) necessary for the work at hand. In some instances optimal magnification is less than the maximum magnification available. While manufacturers' claims of vertical resolution initially appeared to greatly exceed theoretical limits, actual results obtained reveal that the digital image processing used in confocal microscopy does significantly improve on conventionally accepted limits of vertical resolution. After evaluating instruments from variety of manufacturers it was determined that two instruments from Zeiss MicroImaging, LLC, were well suited the continuing research needs of the research.

It has been determined that when carefully chosen and set up, confocal microscopes can yield the quality of data necessary for continued research, and can remain potentially valuable operational forensic laboratories.

Confocal Microscopy, Firearms Examination, Instrument Selection