Sarah Hainsworth, J Forensic Res 2012, 3:8
http://dx.doi.org/10.4172/2157-7145.S1.002

OMICS Group Conferences
Accelerating Scientific Discovery

International Conference on
Forensic Research & Technology

October 15-17, 2012 DoubleTree by Hilton Chicago-Northshore, USA

The role of micro-computed tomography in tool mark analysis

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Multi detector X-ray computed tomography (MDCT) has been widely adopted by forensic pathologists for performing "near virtual autopsies" where the cause of death can in some circumstances be determined without the need to resort to a full autopsy. The technique uses X-rays to generate tomographic images or slices of specific areas. The slices are then reconstructed by software to produce a three-dimensional image of the inside of the body. The X-ray images are taken by rotating the source and detector around the body usually in the form of the body passing through a ring. Different tissues attenuate the X-rays to different extents and therefore bone, cartilage, water and air give differing contrast in the image. The maximum isotropic spatial resolution in a medical CT is approximately 0.4 mm which is limited by the pixel size of the detectors. A major advantage of medical CT for forensic pathology is that the usual constraints associated with X-ray dose for "live" patients are not an issue.

Micro computed tomography offers considerably enhanced resolution over medical X-ray computed tomography. A Nikon Metrology XTH 225 micro-CT scanner, with a Paxscan detector has been used for imaging a range of tool marks on bone. Data has been reconstructed using Nikon Metrology's proprietary software and all rendering and subsequent analysis is performed in VGStudioMax 2.1. The resolution of the technique is influenced by a number of factors, including; the inherent resolution of the X-ray detector, focal spot size, geometric magnification, stability of the rotation mechanism and the filtering algorithm utilised for CT reconstruction. However, resolutions of 6-10μm are achievable.

The images obtained from micro CT are compared to the details available from stereo optical microscopy and scanning electron microscopy and the advantages and disadvantages of each technique for imaging tool marks in forensic applications is discussed.

Biography

Sarah Hainsworth is a Professor in the Mechanics of Materials group. Her research interests are in automotive tribology, forensic engineering, microstructural evolution in power plant materials (steel and Ni-based superalloys) and materials characterization. Her research has been recognized by the award of the Institute of Mechanical Engineers Tribology Bronze Medal (1995) for technical contributions in the field of tribology; the Institute of Metal Finishing Jim Kape Memorial Medal (2007) for a paper of significance in the field of aluminium finishing; and the Rosenhain Medal of the Institute of Materials, Mineral and Mining (2008) for distinguished scientific achievement. Sarah is a Chartered Engineer, Chartered Scientist and Fellow of the Institute of Materials, Minerals and Mining. Sarah is Director of the Faculty of Science Advanced Microscopy Center and manages the Department of Engineering Philips XL30 ESEM facility. She works widely with industry in failure analysis of engineering materials.

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