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Surface chemistry of gunshot residue (GSR) particles by time of flight secondary ion mass spectrometry (ToF SIMS) - Complement to electron microscopy (SEM/EDX)

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Abstract

Time-of-flight secondary ion mass spectrometry (ToF SIMS) is used to complement scanning electron microscopy/ energy dispersive X-ray spectroscopic (SEM-EDX) analysis of gunshot residue (GSR) particles. The research presented here is a study of gunshot residue (GSR) discharged by 0.22 Remington Gold ammunition. SEM-EDX is used to detect the morphology and chemical composition of the discharged particles. Spherical and non-spherical particles in the size range of 3-50 µm are observed and their compositions are examined using EDX. Composition varies with the size and shape of the particles. Combination of lead (Pb), barium (Ba) antimony (Sb) or Pb, and Ba are found and characterized as GSR particles. The same specimens are further subjected ToF SIMS analysis with a view to identify the respective surface chemistry, molecular nature and molecular mass of the GSR particles. Secondary ion mass spectrum and the image analysis are carried out for selected particles. The mass peaks of oxides of lead, barium and antimony apart from the elemental masses are found. The combination of Pb/Ba/Sb and their oxides in a particular particle specifically establish the characteristics of a typical GSR particle. Molecular imaging and the distribution of the components in the GSR particle before and after sputtering are studied. Lead and its oxide are more concentrated in the surface of the particle compared to Ba and Sb. It is evident that SIMS can detect whether the components are either in the elemental or a compound form or a combination of both. The results of ToF SIMS clearly establish the feasibility of utilizing ToF SIMS as a tool for direct characterization of GSR from environmental polluted particles of the same nature for forensic applications.

Biography

Zachariah Oommen has been working as the Director and Professor of Forensic Science program at Albany State University, Albany, Georgia. He has 20 plus years of teaching service. He joined in the department of Criminal Justice and Forensic Science in August 2002. He got promoted to Associate Professor in the fall of 2007, Director of the program in 2011 and promoted to Full Professor in 2012. He has 20 plus years of teaching service in CMS College, Mahatma Gandhi University, Kerala, India, before he joined ASU. He did his Ph.D. at Mahatma Gandhi University, Kerala, India, in 1997 and post-doctoral research at the University of Leuven, Belgium. During his tenure in Albany State University he has been awarded two external grants and 9 internal grants. His active involvement in research has credited to his account about 24 research publications in international/national journals. He has presented several scientific papers in national and international conferences.

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