Lasers in Forensic Science

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Abstract

The application of scientific methods of observation and analysis to detect and interpret clues materials at the site of crime as well as analysis of forensic exhibits in the laboratory which include, inter alia, elemental analysis, fluorescenes of fingerprints, biological stains and other chemicals, particle size analysis, time lapse photography, Raman Laser Probe etc.

Introduction

Lasers play important roles in the field of research in science and technology. They are used to solve many scientific, technological, industrial, military, medical and other problems. Portable Laser sources have been developed to facilitate their use at the site of crime for locating latent fingerprints, hairs, fibres, body fluid stains, gunshot residues and other physical clue materials. In forensic field, lasers have been used for zonal application of photons to analyse elemental composition of minute samples; fluorescence of fingerprints, chemical erasurers, chemical and biological stains etc., recording of corneal turbidity for the determination of time lapsed after death, particle size distribution analysis, time lapse photography, Raman Laser probe, crime scene investigation etc. Lasers are also used for the detection of indentations in documents, recording of footprints on rugs, comparision of fingerprints, crime scene photography, stress and fatigue in metals and recording of strations for contour analysis.

Elemental Analysis

The Pulsed lasers can provide very high rate of temperature rise (about 10^{10} degrees per second or more) on an opaque substance. Due to such high temperature rise the surface layer is evaporated completely which is excited by a spark and the spectrum can be observed by spectrochemical analysis of surface films[1,2]. The laser probe excitation[3] has been used to study elemental composition of paint layers[4,5]; gunshot residues[5,6]; ink documents[7], metallic fragments, body fluid stains[6], gold plating[8] etc.

Walting et al.[9] investigated the potential of laser ablation inductively coupled plasma mass spectrometry using a fine focus Nd:YAG laser for the analysis of solid samples like glass and steel from crime scenes. Stoecklein et. al.[10] have also investigated the use of above technique for determining impurities in glass in addition to major and minor elements.

Detection of Latent Fingerprints

Plamer sweat consists of several compounds like salts, amino acids, lipids, proteins, vitamins, riboflavin and pyridoxin etc. in tiny amounts. Dalrympt et al.[11] studied the excitation-emission spectra of fingerprint material and observed that the absorption band responsible for the yellow green fingerprint luminescence and the 514.5 nm argon laser line are almost ideally matched. They demonstrated the use of cw argon ion laser by detecting fingerprints on paper, knife blades, cups, glass bottle, paper towel, living skin etc.

The treatment of fingerprints with combination of ninhydrin and trypsin as well as ninhydrin followed by treatments with zinc chloride was also experimented[12] with good results. Ninhydrin method combined with enzyme treatment[13] was found suitable for the detection of fresh latent fingerprints. Cheng[14] observed that Nd: YAG laser was suitable for the visible bloody fingerprint treated with ninhydrin/zinc chloride. For old fingerprints, the treatment of latent fingerprint with chemical reagent NBD chloride (4-chloro-7 nitrobenzo furozan) followed by the excitation with 150 watt xenon arc lamp filtered to transmit light in the 475nm spectral region was found fairly successful[15, 16]. Allred et al.[17] have described a lipid specific lanthamide-based method of latent fingerprint detection on currency.

Body Fluids and other Fluorescent Materials

Several body fluids fluoresce und ultraviolet and laser sources, which are valuable tools in the screening of crime samples for body secretion stains[18]. Laser induced DNA typing[19, 20] is used to detect dye-labeled, polymerase chain reaction amplified alleles in DNA typing of forensic samples[19]. A computer controlled scanner for enhanced photography has been developed[21] which is very useful when the angle of lighting is critical or when very long exposures are required.

Time Lapse Photography and Interferometry

Cain[22] has described a technique of utilizing time lapse photography in conjunction with fibre optics and helium neon light source for recording the striae appearing along the edges of single counterfeit currency note. Thornton and Cashman[23] used laser beam interferometry for the reconstruction of fractured glass with the help of Fizeous fringes and argon laser source.

Raman Laser Microprobe

Raman Laser microprobe is much useful for the examination of micron size samples. Guineau[24] used this method with argon laser source to identity inorganic pigment used in ancient manuscripts. Cheng et al.[25] explored the method of identification of traces of explosives like RDX and PETN using Raman Laser microscopy.

Halographic Applications

Double exposure hologram interferometry has been suggested to record hard-to-see footprints on carpets[26] and fingerprint identification[27]. When suitable equipments are available these proposed methods could solve many problems which are very difficult otherwise.

Miscellaneous

Cornea gradually turns opaque after death. The time of death can be predicted more accurately by an objective estimate of the corneal turbidity with a laser apparatus[28]. A review of the literature on different kinds of chemical microscopy including laser and holographic microscopy has been published by cooke[29].

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