B69 Fingerprint Detection by Two-Photon Excitation With a Femtosecond Fiber Laser

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After attending this presentation, attendees will better understand a method of detecting fingerprints by two-photon excitation with an infrared femtosecond laser.

This presentation will impact the forensic science community by providing a non-contact, non-destructive, and non-invasive method to detect fingerprints. The proposed method does not affect DNA testing, which is one of the most important evidences in crime investigation.

Various methods such as using powder or chemical solutions are used for fingerprint detection. Conversely, methods using light such as laser and Light-Emitting Diode (LED) attract attention as a non-invasive method.[1] Fingerprint detection using fluorescence is an especially useful technique in forensic sciences. The visualization of latent fingerprints with an Ultraviolet (UV) -pulsed laser by time-resolved spectroscopy has been studied.[2] Even if the fluorescence of a background is strong, it is possible to visualize fingerprints by this time-resolved method using the difference of fluorescence lifetimes; however, it is a concern that fingerprints and deposits around them are damaged by UV light, which may affect other forensic examinations. It is important to use a less destructive method for criminal identification.

Therefore, this study focused on two-photon excitation with an infrared femtosecond laser. The visualization of latent fingerprints by two-photon excitation with a femtosecond solid-state laser is presented.[3] A compact system for on-site use is currently being constructed by replacing a large Ti:Sapphire solid-state laser to a small fiber laser, because mobility is required. In this study, fingerprint detection by two-photon excitation with a femtosecond fiber laser was performed in order to miniaturize the system.

Two-photon excitation was carried out with a femtosecond fiber laser and a fast-gated image Intensified Charge-Coupled Device (ICCD) camera. Repetition rates of the laser and ICCD camera were 50MHz and 500kHz, respectively. Pulses were picked with a frequency divider for the time-resolved spectroscopy. Damage to samples was reduced by scanning laser light with a galvano mirror and a resonant scanner. The objective lens was 20X (*N.A.*=0.4). Samples were placed on an X-Y-Z axis motorized stage. The excitation wavelength was 780nm and laser power was approximately 200mW to 300mW. Two-photon excitation at 780nm corresponds to one-photon excitation at 390nm. The irradiated area was approximately 50µm x 50µm.

At first, tests were performed using a green fluorescent pen. Gate width and exposure time were 10ns and 10s, respectively. A fluorescence spectrum whose peak of approximately 500nm was acquired. Since the peak of the emission spectrum was shorter than 780nm of excitation, it was confirmed that two-photon excitation occurred using this system with a fiber laser. Subsequently, the fluorescence spectrum of a fingerprint was measured. Gate width and exposure time were 2ns and 60s, respectively. A broad spectrum ranging from 400nm to 500nm was obtained, whose peak was approximately 450nm. It consists of the previous experiments using a femtosecond solid-state laser. Therefore, these results suggest that it was due to two-photon excitation of the fingerprint with the fiber laser. Furthermore, the lifetime of the inherent fingerprint was measured and found to be approximately 1.5ns. Finally, latent fingerprints on ceramics were visualized. Gate width and exposure time were 8ns and 20s, respectively. The ridge of a fingerprint was detected by two-photon excitation. In addition, fluorescence of a piece of skin was strongly detected. For future consideration, the researchers plan to visualize the fluorescence of additional fingerprints.

Reference(s):

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3. Akiba N., Kuroki K., Kurosawa K., Tsuchiya K., Takeuchi S., Shimoda O., Takatsu M., Yamaguchi A., Iriyama T., Sota T. Fingerprint Imaging by two-photon excitation, *Proceedings of the 13th Conference on Methods and Applications of Fluorescence: Spectroscopy, Imaging and Probes*. 2013. Genova, Italy.

Fingerprint, Fluorescence, Two-Photon Excitation