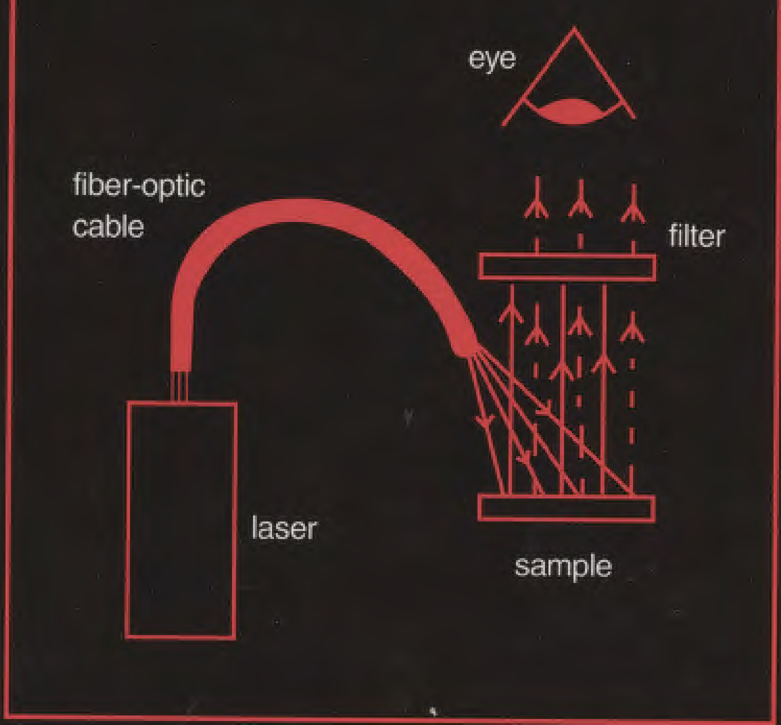
Fingerprint Detection with Lasers

Second Edition, Revised and Expanded



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Photoluminescence-Based Physical Treatments

In the early days of laser fingerprint detection, the focus was on detection via inherent fingerprint luminescence [1], although dusting, staining, and chemical procedures were also considered. From a conceptual perspective, the major strategies for fingerprint detection by photoluminescence, either by laser or incoherent light sources, had been delineated by 1980 [2–7]. Starting with the 80s, major focus began to target development of better chemical fingerprint treatments, to be dealt with in Chapter 8, and treatments for time-resolved imaging, discussed in Chapter 9. In this chapter, physical methods are discussed, starting with fingerprint detection by inherent fingerprint fluorescence.

7.1 INITIAL INVESTIGATIONS [1]

It was recognized in 1976 that fingerprints, fresh and old, could be detected in a rather general way, on a range of surfaces, thus rendering the photoluminescence approach a potentially general one. Thus, the initial investigation considered a range of aspects of the general approach, which are enumerated in this section. Details will be taken up in the pertinent subsequent sections.

Fingerprint fluorescence. The issue of whether the observed inherent fingerprint fluorescence is indeed inherent or a matter of contamination of fingers by fluorescent material was taken up.

Spectroscopy of fingerprint residue. A fairly extensive study was necessary from the outset for the best choice of excitation source and filter selection for fingerprint luminescence observation and photography.

Conditions under which fingerprints could be detected. Here, a range of surface types were examined and potential fingerprint age limitations were investigated. Also, issues of compatibility with the then conventional fingerprint detection procedures were addressed.

Excitation sources. A comparison was made of laser versus incoherent light sources, the latter these days being referred to as alternative light sources. Although filters have improved since 1976, the then stated conclusion that the alternative light sources, though portable, would be an order of magnitude less sensitive than the large Ar-lasers remains valid today.

Fingerprint treatments. Early on it was realized that background fluorescence would make it necessary to devise fingerprint treatments that would lead to more intense fingerprint luminescence or luminescence of a color different from that of the background, to permit optical filtering for background suppression. The focus then was on dye staining. Today, such staining after cyanoacrylate fuming is a bread-and-butter photoluminescence detection procedure. By 1980, dusting powders and chemical treatments had been devised. However, the chemical treatments were not comparable in sensitivity to those that would follow later.

Fingerprint phosphorescence. Here, the recognition that fingerprint development would allow suppression of background fluorescence (the time-resolved approach) pertains. By 1979, the feasibility of this strategy had been demonstrated but it would take another 15 years to bring the approach to maturity from the instrumentation perspective. From a chemistry perspective, time-resolved imaging is not truly mature even today. However, there are several procedures that have reached the maturity required for operational implementation. These will be taken up in Chapter 9.

Fingerprint age determination. The potential of determining fingerprint age by photoluminescence techniques was envisioned early on. A comprehensive study involving inherent fingerprint fluorescence would be undertaken in the early 80s, with no success. This is an important area that remains elusive even today.

7.2 INHERENT FINGERPRINT FLUORESCENCE

A material, in order to yield photoluminescence, must first absorb the incident luminescence excitation light. Thus, we examine the absorption of fingerprint residue, sketched in Fig. 7.1. Not surprisingly, fingerprint residue absorbs best in the deep ultraviolet, corresponding to absorption by relatively small organic molecules. As pointed out in Part I of this volume, there are no lasers operating in this range that are of practical use in a law enforcement fingerprint identification section. UV lamps are not sufficiently intense either. Fortunately, there is (albeit weak) absorption in the blue-green, leading to fluorescence. This prompt-

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