TECHNICAL NOTE

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Permeation of Fingerprints Through Laboratory Gloves

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ABSTRACT: Repeated controlled tests have shown that impressions from laboratory gloves will print onto optical components in 20 to 40 min and, in some cases, sooner. Careful testing demonstrated that palmar sweat passed through the glove material; the problem was not that gloves conform to the friction ridges of the fingers and then transfer some contaminant. The problem can be alleviated to a great extent by wearing thin cotton gloves like those commonly used in the film industry.

KEY WORDS: criminalistics, fingerprints, gloves, latent print, palmar sweat

Surgical-style gloves are used in any laboratory environment where it is desirable to avoid contamination from palmar sweat. Much literature has been devoted to the subject of psychological stress and the involuntary stimulation of eccrine glands producing palmar sweat. This increased sweat, a blessing to a polygraph operator, becomes the bane of the scientist or technician handling expensive optical components. The psychological stress is significant considering that a single smudge on a critical optical component could destroy that component, not to mention a career.

The University of Dayton Research Institute (UDRI) operates the Optical Component Evaluation Laboratory (OCEL) on Kirtland Air Force Base in Albuquerque, N. Mex., for the purpose of characterizing high-energy laser components. Many of the optical components have unique coatings that would be seriously degraded or irreparably damaged by even the slightest fingerprint smudge. Not considering those materials soft enough to replicate the palmar friction ridges merely by pressure, the compounds contained in palmar sweat may etch delicate dielectric coatings [*1,2*]. Furthermore, some optical coatings not damaged by palmar sweat would be damaged by the reagents used to clean the print residue from the optical component.

The OCEL technicians routinely wear surgical-style protective gloves while handling optical components. But after the gloves were worn for 20 min, smudged areas appeared on the optical component, and after 40 min prints with clear ridge detail were apparent.

Systematic tests of the five types of surgical-style gloves commonly used in the laboratory and a disposable cotton glove used in the film industry were evaluated along with controls.

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The test monitored the time required for each of the glove styles to allow permeation of palmar sweat onto a sample optical component and notebook paper.

The subjects took extreme care to avoid contamination of the glove's exterior and to eliminate the possibility of the material conforming to the friction ridges of the fingers and transferring some unknown substance as a latent print. This was accomplished by not touching anything.

Conventional methods fail to make latent prints visible on nonporous substances such as optical components. In such cases the laser luminescence method of Dalrymple et al [*3*] will reveal exquisite detail. Latent prints on porous materials, such as notebook paper, can be detected by using one of several chemical methods: ninhydrin, silver nitrate, iodine fumes, iodine with 7,8-benzoflavone, or *ortho*-phthalaldehyde. The powder-dusting methods of latent print detection proved only marginally successful and fail to prove the permeation of palmar sweat.

Twenty-three subjects aged 19 to 55 from various ethnic/cultural groups were used for the test. Studies indicate there is some variation in the number of active eccrine sweat glands and the amount of palmar sweat produced by different racial/ethnic groups [*1,4*]. The test was composed of four steps:

1. Subject presses palm flat on a sheet of paper.
2. Subject puts on the glove and then presses gloved palm on a different sheet of paper.
3. Subject presses gloved left index finger on a test optical component.
4. Steps 2 and 3 are repeated at 5-, 10-, 20-, 40-, and 60-min intervals.

After these four steps volunteers scrubbed their hands with either Betadine® scrub or Octagon® brown soap. After a 10-min surgical scrub, they repeated the sequence.

The results of repeated tests indicated that after 40 min almost all thin disposable laboratory and surgical-type gloves will allow permeation. Table 1 shows the glove type tested versus the permeation time onto an optical component.

In three cases there was an almost instantaneous impression of some indistinct smudges on paper. The mechanism by which the impression occurred is not fully understood. To clarify this mechanism, a glove was worn for 40 min. Then it was very carefully removed without contaminating the exterior, and a rubber stamp was placed inside the glove where the palm had been and the glove was pressed onto paper. A latent print of the stamp developed by chemical means. Apparently either a significant amount of palmar sweat was extruded through the glove or the material of the glove may have acted as a blotter.

TABLE 1—*Glove type versus test time on a test optical component.* [a]

Glove	Test Time, min					
	0	5	10	20	40	60
Vanlab® (VWR Scientific)	—	a	b	c	c	c
Fisher® polyvinyl chloride (Fisher)	—	—	a	c	c	c
Tru-Touch® vinyl (Bard-Parker)	—	a	a	b	c	c
Micro-Touch® latex (Arbrook)	—	—	—	c	b	c
Shur-Touch® latex (Bard-Parker)	—	—	—	a	a	c
100% cotton (Kodak)	—	—	—	—	—	a

[a] Key:
— = No reaction.
a = barely observable indication of smudge.
b = ridge detail.
c = classifiable print.

Thus, the rubber stamp or the pressure ridges of the finger caused enough increase in pressure to diffuse palmar sweat through the semipermeable membrane of the glove.

Table 2 shows the type of glove tested versus the time required to leave an impression on paper. Table 3 shows the impression time after subjects thoroughly scrubbed their hands.

Plain cotton gloves will not allow the fingerprint to print through onto paper, although after an hour they will occasionally leave slight smudges on optical components. In processing the notebook paper for latent prints with a ninhydrin-Freon® solution, the extreme porosity of the surgical latex gloves became obvious to the casual observer because of the large blotchy areas of the fingers and hands stained magenta by the ninhydrin reagent.[2] When the latent prints were developed with ninhydrin solution, a considerable variation from subject to subject was noted. Some of this variation can be considered a function of psychological stress.

There are three implications of glove impressions:

1. In the case of forensic science, materials handled for any length of time will disclose the criminalist's latent prints along with those of the suspect.
2. The impression on optical components is even more sensitive than that on porous materials because no fiber saturation is required. The implication of a deposit on any high-power laser optical component is that the constituents of palmar sweat absorb more energy than the optical component, thereby lowering the damage threshold.
3. Palmar sweat on the cavity resonators of an iodine laser will degrade the output beam as the prints develop. The prints do develop even at low vapor pressures.

When it is necessary to handle an object without leaving any latent prints or any vestigial remnants of palmar sweat, thin cotton gloves should be worn. If it is necessary to isolate the skin from the object, then surgical gloves should be worn under the cotton gloves.

TABLE 2—*Glove type versus test time on paper.*[a]

Glove	Test Time, min					
	0	5	10	20	40	60
Vanlab (VWR Scientific)	—	—	a	b	c	c
Fisher polyvinyl chloride (Fisher)	—	—	—	c	b	c
Tru-Touch vinyl (Bard-Parker)	a	—	—	a	a	b
Micro-Touch latex (Arbrook)	—	—	—	b	b	b
Shur-Touch latex (Bard-Parker)	a	—	—	—	a	b
100% cotton (Kodak)	—	—	—	—	—	—

[a] Key:
— = no reaction.
a = barely observable indication of smudge.
b = ridge detail.
c = classifiable print.

[2] The FBI's Administrative Advanced Latent Fingerprint School in Quantico, Va., uses a ninhydrin-Freon solution with ethyl alcohol as the solvent for the ninhydrin powder. The Albuquerque Police Department's Criminalistic Division uses methyl alcohol as the solvent for the ninhydrin powder. This ninhydrin/methyl alcohol solution then becomes the solute of the Freon TF® (305-8M) (trichlorotrifluoroethane). The Freon TF, a nonphotochemically reactive solution, does not interfere with further future developments of silver nitrate or iodine 7,8-benzoflavone.

TABLE 3—*Glove type versus test time on paper after subjects thoroughly scrubbed their hands.* [a]

Gloves	Test Time, min					
	0	5	10	20	40	60
Vanlab (VWR Scientific)	—	—	—	a	b	c
Fisher polyvinyl chloride (Fisher)	—	—	—	a	b	b
Tru-Touch vinyl (Bard-Parker)	—	—	—	a	a	b
Micro-Touch latex (Arbrook)	—	—	—	—	a	a
100% cotton (Kodak)	—	—	—	—	—	—

[a] Key:
— = no reaction.
a = barely observable indication of smudge.
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