Menachem Tassa,[1] *Ph.D.; Nachum Adan,*[2] *B.S.;*
Nathan Zeldes,[2] *M.S.; and Yacov Leist,*[2] *M.S.*

A Field Kit for Sampling Gunshot Residue Particles

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ABSTRACT: The application of scanning electron microscopy to gunshot residue particle detection requires a field sampling kit that can be used dependably by nonscientific field personnel. The kit developed by the authors uses adhesive tape on aluminum stubs to sample the suspect's hands. The kit evolved from prototypes that were subjected to extensive field tests. Comments by users pinpointed various shortcomings that were eliminated; the final version is suitable for rapid, straightforward application in the often hectic environment in which field officers must operate. The kit is also compact, durable, and inexpensive; it is thus especially suitable for large-scale fabrication, issue, and use on a regular basis.

KEYWORDS: criminalistics, chemical analysis, gunshot residues, scanning electron microscopy, sampling kit, particle analysis

The scanning electron microscope (SEM), coupled with an X-ray microanalyzer, has been recognized as a powerful tool for the detection and identification of gunshot residue (GSR) particles on suspects' hands [*1,2*]. A serious problem in the use of this method on a regular, large-scale basis is that since a single SEM laboratory must serve a large geographical area, and since speedy sampling is essential, suspects must be sampled outside the laboratory by local police officers with no scientific background. These officers must therefore be provided with kits suitable for the twin functions of collecting the particles from the suspect and conveying them safely to the laboratory for analysis. Basically, any field kit for sampling microscopic evidence must be:

(a) efficient in extracting particles of the desired type,
(b) simple to use, so that its application can be entrusted to nonscientists,
(c) sufficiently rugged to withstand rough handling (such as distribution by mail or storage in a tool kit or car trunk), and
(d) inexpensive and easy to fabricate in quantity.

These design objectives have guided the development by the authors of a kit that is currently being used by the Criminal Identification Division of the Israel Police on a nationwide scale.

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[1]Deputy head, Criminal Identification Division, Israel Police Headquarters, Jerusalem 91999, Israel.
[2]Head and laboratory officers, respectively, Tool Marks and Materials Laboratory, Criminal Identification Division, Israel Police Headquarters, Jerusalem 91999, Israel.

The Sampling Medium

The authors use the sampling method described by Wolten et al [*1*], which involves coating an SEM specimen carrier (stub) with two-sided adhesive tape. The use of stubs allows immediate transfer of the samples from the kit to the graphite coater and into the SEM without any intermediate mounting operations. Of course, any other adhesive medium (such as the thin glue layer described by Basu and Ferriss [*3*]) could be used on the stubs instead of the tape, without changing the kit in any significant way. The SEM used (a CamScan 3-30 ADP) accepts disk-like stubs with a central mounting pin, which can conveniently serve as a handle for the disk.

Prototype Field Kit

The adhesive-coated stubs were initially distributed in a prototype kit containing the following:

(a) four stubs,
(b) disposable nylon gloves,
(c) a detailed two-page instruction sheet, and
(d) a lengthy form for suspect identification and case data.

The stubs, with the protective paper layer still on, were mounted in pairs in two rubber-padded plastic boxes, and the entire kit was packaged in a cardboard box and sealed in an outer polyethylene bag (Fig. 1).

To use this kit the officer would don the gloves, open the boxes, extract a stub, remove the protective paper, sample the suspect's hand, and plug the stub back into the rubber padding. Two stubs were used on each hand. The officer would then fill in the form and the stickers on each box and send the kit in its cardboard box for analysis.

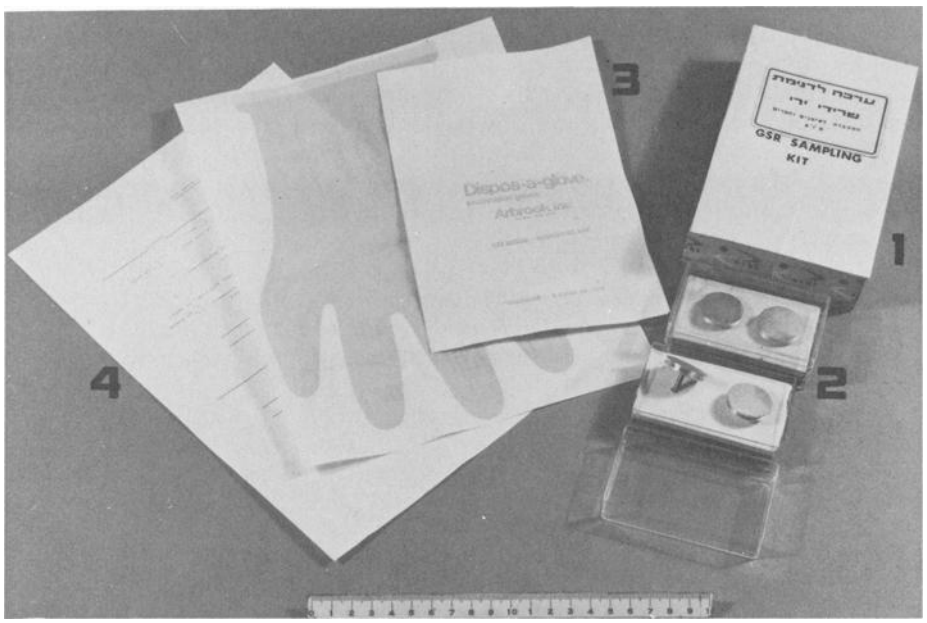

FIG. 1—*Prototype field kit.* 1. *Cardboard box.* 2. *Stubs.* 3. *Disposable gloves.* 4. *Instructions and form.*

Some 250 kits with different variations of this basic design were distributed to scene-of-crime officers all over the country. After an experimental period of seven months, the following criticisms had been repeatedly raised:

a. While the stubs were being held by the edges of the adhesive disk (during their replacement into the box) the gloves would often stick to the sampling surface, with various disastrous results.
b. The transfer of the stubs from hand to hand (so as to peel off the protective paper and grip the handle), and their return into the box, caused many stubs to be dropped.
c. Too much writing was required (on the form and the two boxes' stickers). Time and again kits were returned with incomplete forms.
d. The plastic boxes were easily broken in transit, or the stubs dislodged from their rubber padding, sticking to the inside of the lid.

It became obvious that the prototype kit was not satisfactory. In retrospect the reason is clear: it was designed with the laboratory environment in mind. The plastic boxes, ideal for specimen storage in the laboratory, were too delicate for field conditions. Application of the kit was too complicated and lengthy, a point of secondary importance in the laboratory but crucial in the pressed and often hectic environment of a police station. If it was to be accepted and used, the kit had to be drastically redesigned.

The Cylinder Kit

The new kit is based on a cylinder made from a short piece of polyvinyl chloride pipe, stoppered at each end with a rubber cork. In each cork's inner face a hole grips the pin of a stub in a tight fit. Each kit contains:

(a) one cylinder with two stubs,
(b) disposable nylon gloves,
(c) a single form, with a short resume of the sampling instructions printed on its reverse side, and
(d) an empty polyethylene bag.

The stubs are packaged without protective paper. The gloves, the form, and the empty bag are all rolled around the cylinder, forming a compact roll that is sealed in a polyethylene outer cover (Figs. 2 and 3).

When the kit is in use, the officer dons the gloves, pulls out a cork, and samples one of the suspect's hands, using the cork as a handle for the stub (Fig. 4). The cork is then replaced in the cylinder and the second stub is similarly used to sample the other hand. The form and the sticker are now filled in and the kit packaged in the empty bag for submission to the laboratory.

This cylinder kit has many distinct advantages over the previous model:

a. The officer does not in any way touch the stub itself. Extraction, sampling, and replacement are done in one short motion and only the cork is held.
b. The form has been shortened considerably.
c. The kit is rugged enough to withstand a drop from a sixth floor window.
d. Size and price are both much reduced.

The cylinder kit has solved all the problems of its boxed prototype. No further complaints from field personnel have been received since its introduction as a standard device of the Israel Police.

FIG. 2—*The redesigned cylinder kit.*

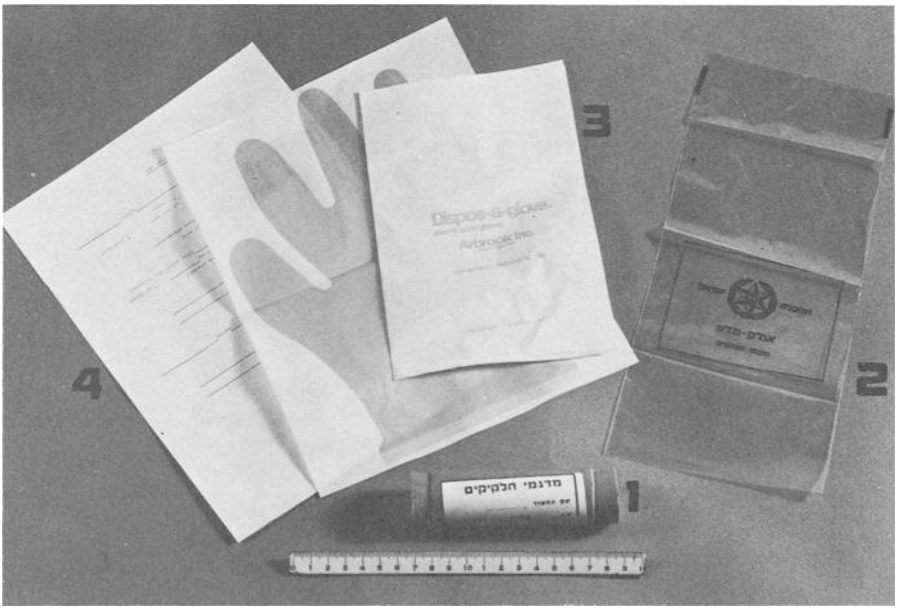

FIG. 3—*Cylinder kit components.* 1. *Cylinder with two stubs.* 2. *Empty plastic bag.* 3. *Disposable gloves.* 4. *Instructions and form.*

Technical Details

Following are some notes in regard to materials and kit fabrication:

a. Stubs to fit our SEM, fabricated of 6061 aluminum, were ordered locally from a machine shop. Machined from a 25-mm rod, they provide a larger sampling area than the standard 12-mm stubs.

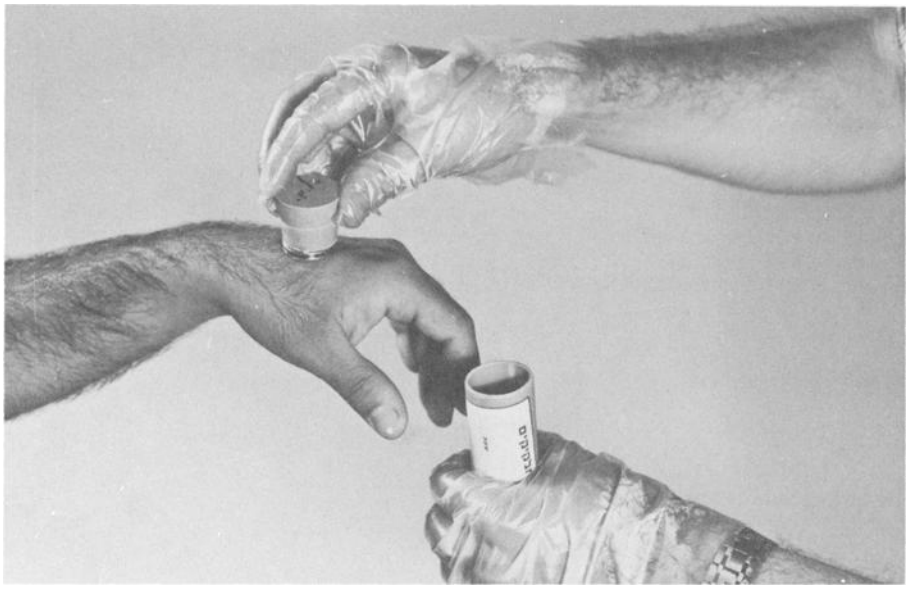

FIG. 4—*Sampling a suspect's hand.*

b. The cylinder is cut from 32-mm outside diameter rigid polyvinyl chloride pipe, which is sold as hot water tubing. This, like all other kit components, has undergone rigorous tests to ensure the absence of any detectable traces of lead, barium, or antimony.

c. The rubber corks to fit the cylinder are of the type used for laboratory glassware.

d. The adhesive tape used is Scotch® (3M corp.) 465.

e. The single sheet of paper that accompanies the kit has a form on one side and brief instructions on the other. The second side also has the label "GSR Kit" printed in one corner so that when the sheet is folded and rolled around the cylinder the label shows through the polyethylene cover.

f. Assembly of the kits is preceded by rigorous ultrasonic cleaning of the stubs, corks, and cylinder; strict precautions are observed throughout fabrication to prevent accidental contamination.

The authors will gladly supply further details upon request.

Summary

The main conclusions derived from this project were as follows. First, simplicity in application and paperwork is of prime importance in the field. And second, large-scale application of a kit that is not simple enough will inevitably result in incorrect use, which no amount of instruction can eliminate. If the kit is not adapted to the environment of the officers using it, they will invariably adapt it by altering or omitting steps in the sampling procedure. These conclusions are applicable to any field kit for police use; indeed, we have described the design history of the gunshot residue kit in detail in the belief that it may serve as a case study whose lesson can be applied to other areas of forensic science evidence.

Acknowledgments

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Address requests for reprints or additional information to
M. Tassa, Ph.D.
Criminal Identification Division
Israel Police Headquarters
Jerusalem 91999, Israel