## CASE REPORT

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# Screen-Printing Ink Transfer in a Sexual Assault Case*

**REFERENCE:** Amick JF, Beheim CW. Screen-printing ink transfer in a sexual assault case. J Forensic Sci 2002;47(3):619–624.

**ABSTRACT:** Yellow plastic-like particles were discovered on the clothing and body of a sexual assault victim. These particles were later associated to an athletic jersey with flaking yellow screen-printed numbers and letters, worn by the suspect. Depending on its intended substrate, screen-print ink can vary in color and composition. Particles dislodged from screen-printed garments may exhibit fabric impressions. Screen-printed clothing, commonly encountered in forensic casework, should be viewed as a potential source of trace evidence.

**KEYWORDS:** forensic science, trace evidence, screen-printing ink, fabric impressions, rape, Sexual Assault Response Team (SART)

In August 1997, a Caucasian female reported being chased by an Alaskan Native male as she jogged on the popular recreational Coastal Trail in Anchorage. The individual overtook her, dragged her into the woods, and sexually assaulted her. The police apprehended a suspect within a few hours.

The victim agreed to a SART (Sexual Assault Response Team) exam at a local hospital where clothing and biological samples were collected. During the examination, the nurse examiner noted a "yellow fleck" on the victim's body. She placed this plastic-like particle in a debris collection envelope within the sexual assault kit. The collected evidence was submitted to the Alaska State Crime Laboratory for analysis. No spermatozoa were detected on the victim's vaginal, rectal, or oral swabs/smears. The DNA profile of a semen stain located on the victim's panties was consistent with her husband. No semen stains were found on the remaining clothing items. A Mongoloid pubic hair was recovered from the victim's sports bra. This hair was microscopically consistent with a pubic hair sample from the suspect. The analyst asked the investigating officer to submit the suspect's clothing to determine if fiber transfers could be detected to strengthen the link between the suspect and the victim. At the time, the significance of the yellow particle in the debris collection envelope was not discernable.

The suspect's clothing lacked suitable target fibers to conduct any meaningful comparisons. However, the yellow screen-printed logo on the suspect's nylon athletic jersey (Fig. 1) reminded the analyst of the yellow-colored particle observed in the victim's debris collection envelope. The analyst also noted that yellow ink particles flaked from the suspect's jersey when it was handled. The source of the particles was apparent when the jersey was examined with the stereomicroscope (Fig. 2). A microscopic comparison of the yellow debris particle from the victim with the suspect's yellow logo revealed similarities in color and texture. Fabric impressions were observed on both the unknown particle and on the logo. Dozens of yellow particles were subsequently noted on the tape lifts that had been used to collect trace evidence from the victim's clothing. Yellow particles from victim and suspect sources were selected for analysis and comparison by microchemical testing, microscopical Fourier transform infrared spectrometry (FT-IR), and pyrolysis gas chromatography mass spectrometry (pyrolysis GC/MS).

## Methods

### *Sample Analysis*

The microchemical reactions of known and questioned screen-print ink particles were compared by simultaneously observing the reaction of the particles to the addition of acetone and chloroform droplets.

The screen-print inks were analyzed with a Bio-RAD Model FTS-60 FT-IR spectrometer (BioRad Corp., Cambridge, MA) equipped with a Spectra-Tech IR-Plan microscope (Stanford, CT). Sample preparation involved placing a small portion of an ink particle between two NaCI disks and compressing it with a compression cell.

The screen-print inks were also analyzed using a Hewlett Packard 5890A gas chromatograph (Palo Alto, CA) with a 30m HP-5MS capillary column and a Hewlett Packard 5971A mass selective detector. A Hewlett Packard 18580A pyroprobe was attached to the gas chromatograph. The samples were pyrolyzed at 800°C for 20 s. The gas chromatograph used the following conditions: injector 225°C, detector 280°C, initial temperature of 40°C for 2 min, 20°C/min ramp, and a final temperature of 250°C for 17.5 min.

### *Used Clothing Examination*

A group of used clothing items were obtained to appraise the potential value of screen-print inks. The garments were examined with low-power magnification under the stereomicroscope to evaluate the fabric substrate and the relative age of the screen-printed logo. Tape lifts were applied to the surface of the logos to determine the ease with which ink particles were dislodged.

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## Results

*Sample Analysis*

The microchemical tests did not reveal any significant information. The screen-print ink particles from the known and questioned sources reacted similarly: the particles exhibited no reaction to acetone and the particles swelled in chloroform. There was good agreement between the spectra and pyrograms from the victim and suspect inks. Analysis by FT-IR (Figs. 3 and 4) and pyrolysis GC/MS (Figs. 5 and 6) indicated that the yellow particles were similar in organic composition and were primarily composed of polyvinyl chloride (PVC).


FIG. 1—*Suspect's athletic jersey with screen-print ink logo.*

*Used Clothing Examination*

Several observations were made during the examination of the used clothing. Screen-print ink on cotton/polyester blend fabrics had a more bubbled surface texture (Fig. 7) than screen-print ink found on nylon athletic shirts (Fig. 8). No fabric impressions were apparent on screen-print ink particles from cotton/polyester blend fabrics. Conversely, fabric impressions were readily visible on ink from the nylon fabrics (Fig. 9). In addition, the relatively new logos had smooth surfaces that shed few particles when disturbed, whereas the worn logos had rough, flaking surfaces that tended to more readily shed particles.

## Discussion

To discern the value of this type of trace evidence, a number of manufacturers were contacted for information about the variety of formulations of screen-print ink available. Samples were obtained from manufacturers and from used clothing sources to evaluate the variability of the inks.

Screen-printing inks are used to print numbers, letters, and designs on garments. Ink selection depends on the fabric substrate and the desired color, durability, and finish of the print design. Manufacturers typically formulate different series of inks for use on specific fabric substrates such as 100% cotton, cotton/polyester blends, and nylon. Some of the major manufacturers of textile inks include QCM (Kent, WA), International Coatings (Cerritos, CA), Rutland (Pineville, NC), Union Ink (Ridgefield, NJ), and Triangle Ink (Wallington, NJ). The most widely used textile inks are plastisols; inks based on vinyl polymers. However, water-based inks and inks based on polymers other than vinyl are also used. Vinyl screen-printing inks are thermoplastic, requiring heat to cure on fabric. The primary ingredients of vinyl inks are polyvinyl chloride (PVC), pigment, and plasticizer. Most companies offer a wide selection of standard colors, in addition to glit-

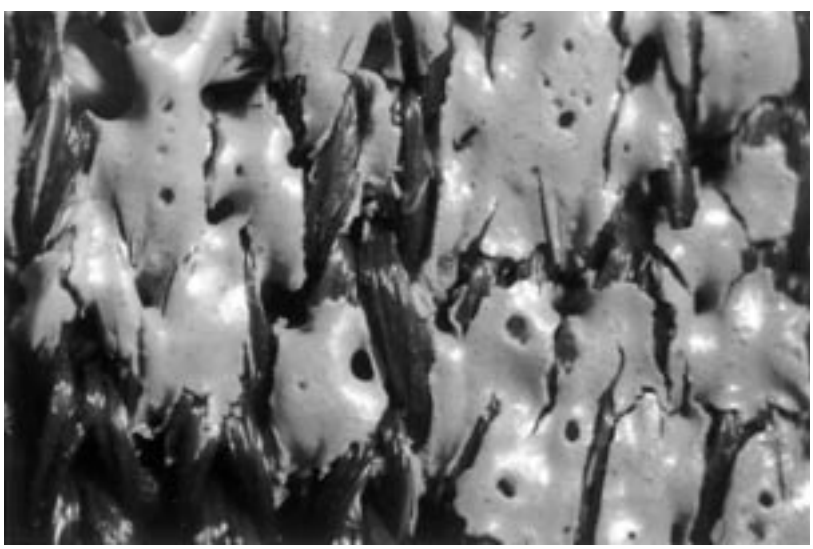

FIG. 2—*Close-up of the worn screen-print ink logo on jersey.*

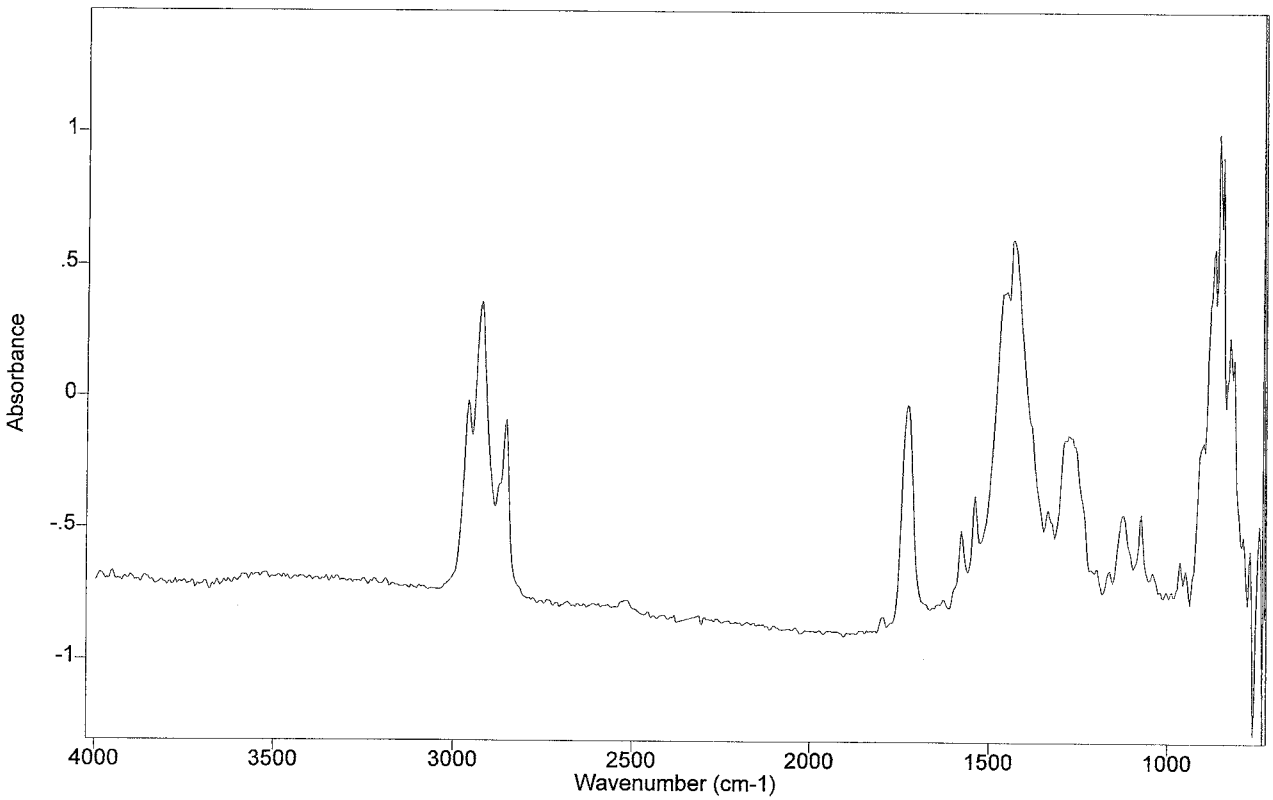


FIG. 3—*FT-IR spectrum of yellow ink particle from victim's sweatshirt.*

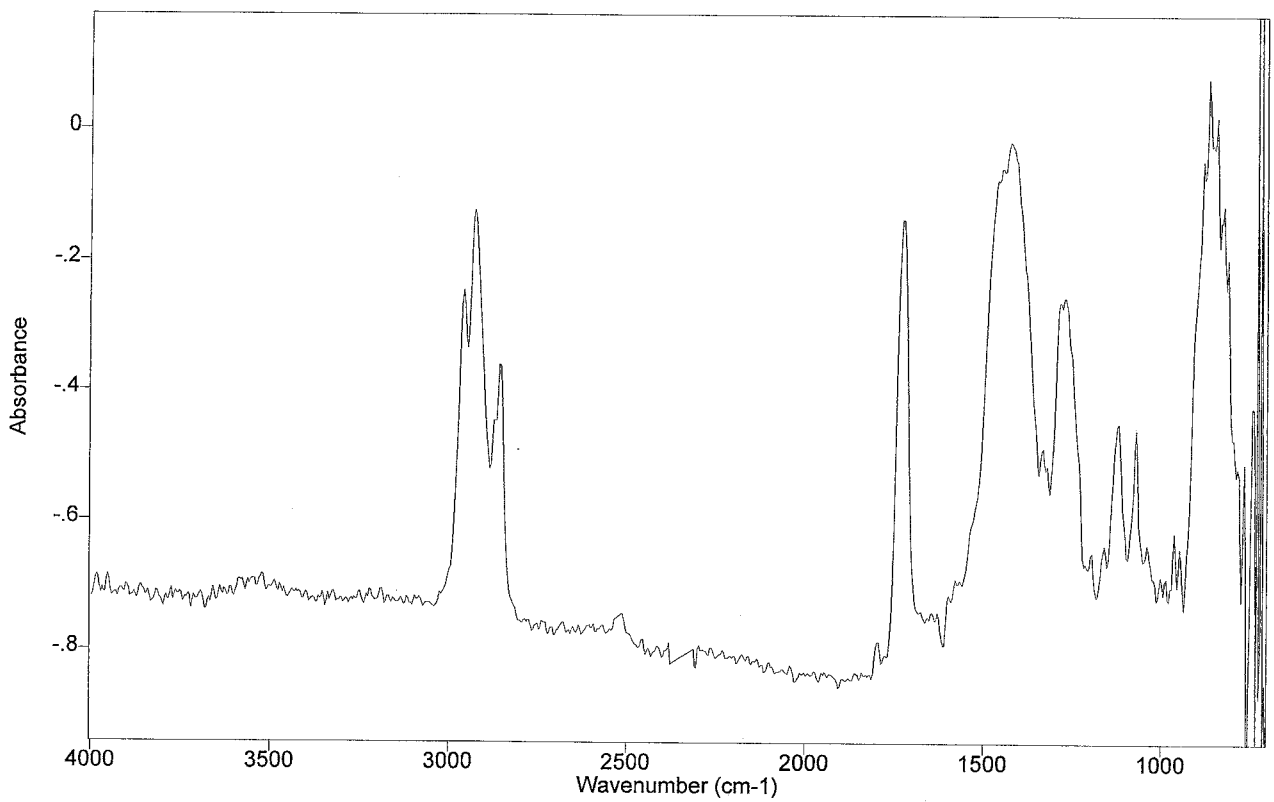


FIG. 4—*FT-IR spectrum of yellow ink from suspect's jersey.*

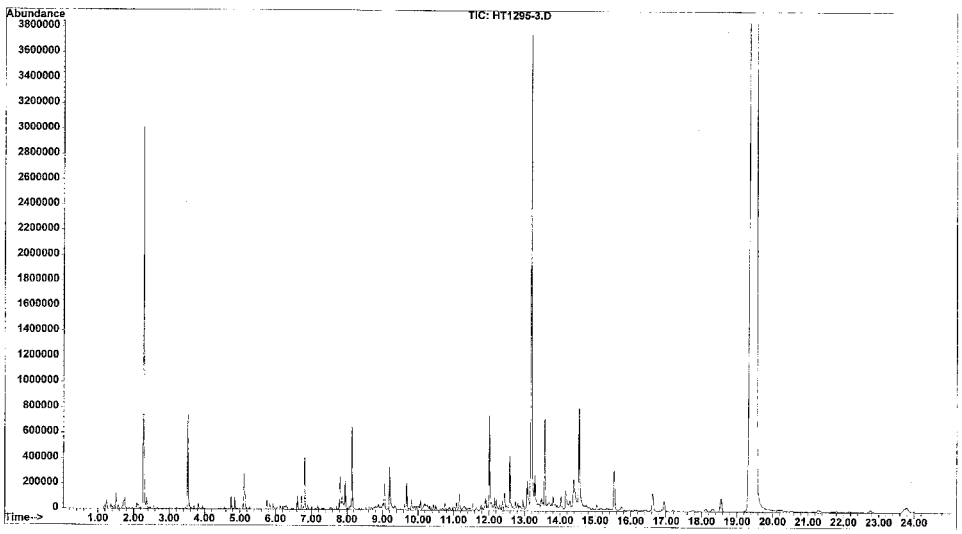


FIG. 5—*Pyrogram of yellow ink particle from victim's sweatshirt.*

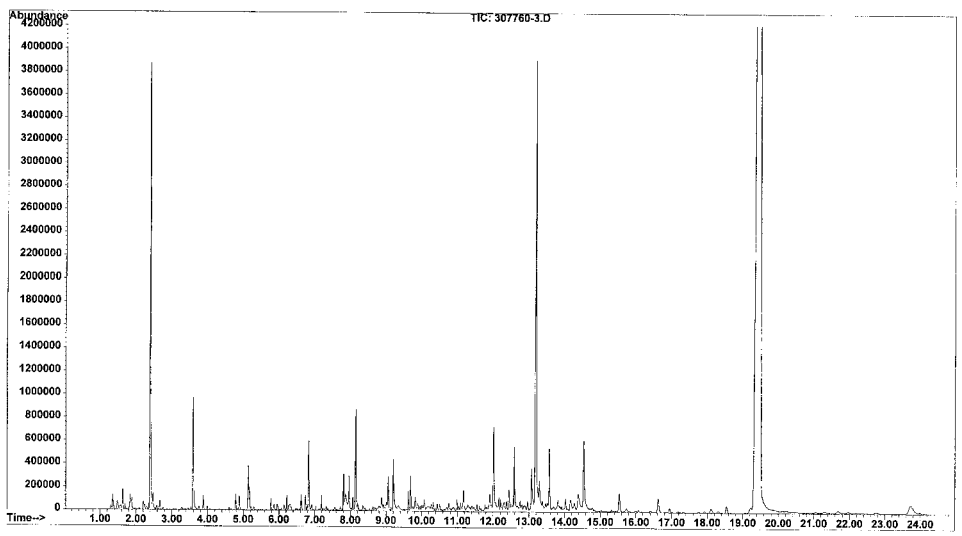


FIG. 6—*Pyrogram of yellow ink from suspect's jersey.*

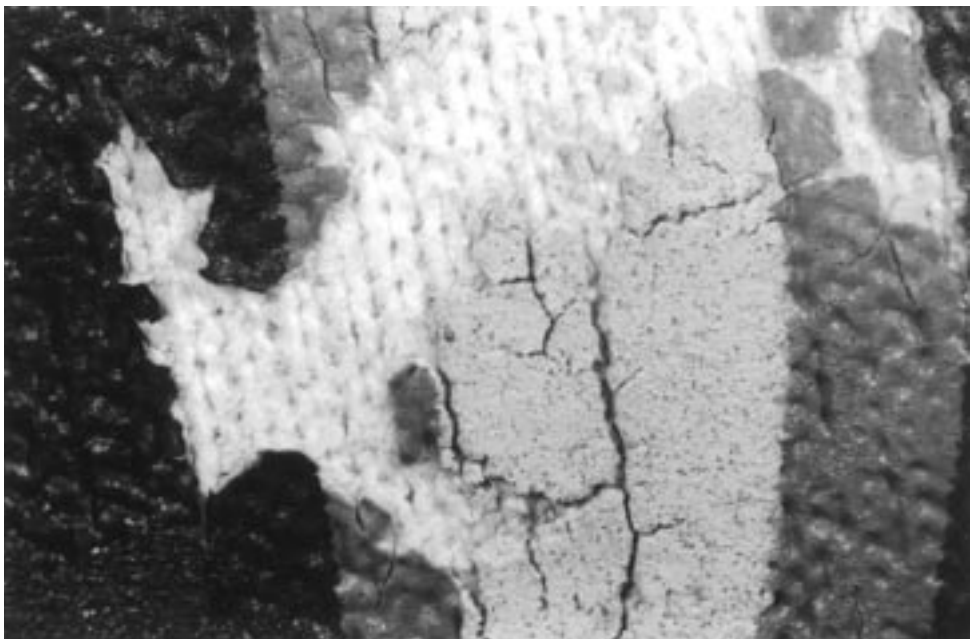

FIG. 7—*Bubbled surface texture of screen-print ink on used cotton/polyester blend shirt. Portions of the ink are worn, exposing the underlying fabric.*

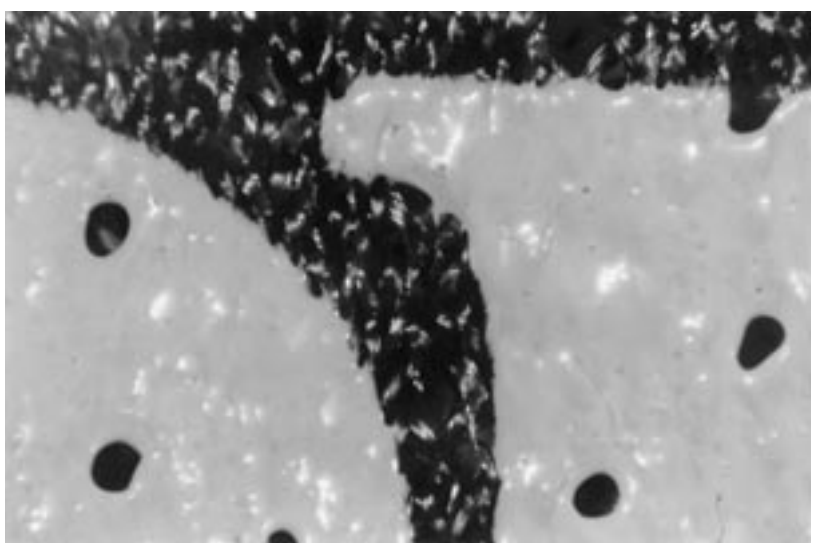

FIG. 8—*Smooth surface texture of screen-print ink on relatively new nylon athletic shirt.*

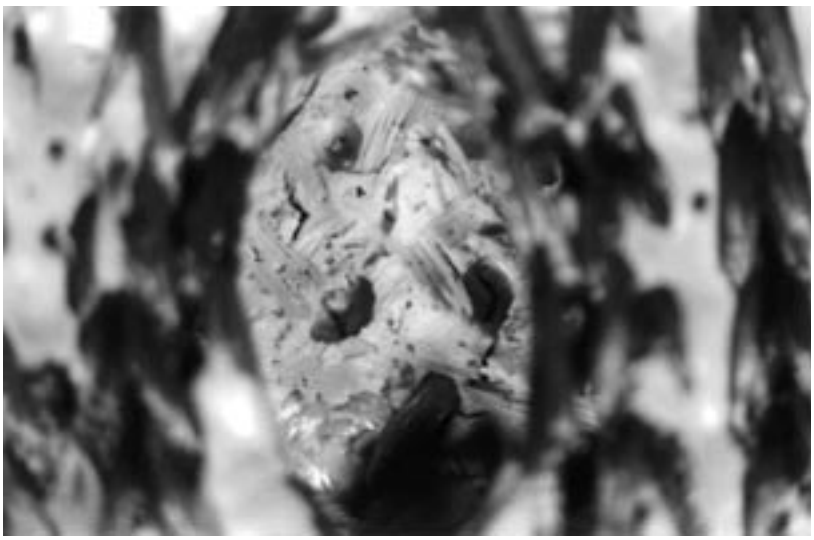

FIG. 9—*Fabric impressions on screen-print ink of nylon athletic shirt.*

ters and metallics. Printers may also create their own special colors. Choice of plasticizer is influenced by the ink flexibility required. One company reports the use of 15 different plasticizers. Various other additives, modifiers, or reducers can also be added to an ink to improve its printability. Because of the assortment of chemicals that may be combined to produce suitable inks, there may be significant variation in the composition of textile inks used on specific batches of garments.

Screen-printed clothing is frequently worn by the general population, increasing the odds that these garments will turn up as evidence in a forensic laboratory. The value of such clothing may have been overlooked in the past because of its common fiber composition or its inability to shed a significant number of fibers. Since screen- printed garments can transfer ink particles that vary in color and composition, examiners may discover that these types of garments can be a potential source of valuable trace evidence. Further study is needed to determine the value in identifying and comparing the pigment and other additives in screen-print ink samples.

The suspect in the highlighted case was convicted of first-degree sexual assault in April 1998 and later sentenced to 45 years. This suspect had served 10 years for a similar rape in 1987, having been on parole at the time of the current sexual assault. While the trial relied heavily on the victim's eyewitness account, the yellow textile ink evidence helped to corroborate contact between the victim and the suspect.

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