


DECLARATION OF ERIC PEPPER

I, Eric Pepper, do hereby state that:

1. I am the Director of Publications with Society of Photo-Optical Instrumentation Engineers (“SPIE”), located at 1000 20th Street, Bellingham, WA 98225-6705.
2. I have been asked to confirm certain dates, publication facts, and public accessibility facts regarding the following paper published by SPIE in the *Proceedings of SPIE* (“the “Proceedings Paper”):
 - A. “Chemical characterization of fingerprints from adults and children” by Michelle V. Buchanan; Keiji Asano; Arthur Bohanon
3. SPIE is a neutral party to the dispute in United States *Inter Partes* Review captioned as IPR2016-01914.
4. Neither I nor SPIE is being compensated for this declaration.
5. I have reviewed and have personal knowledge of SPIE records relating to the Proceedings Paper, such records being maintained as part of the ordinary course or business of SPIE.
6. On February 5, 1997, the Proceedings Paper was published and available for distribution and public accessibility in print format by SPIE in Proceedings of SPIE Vol. 2941: *Forensic Evidence Analysis and Crime Scene Investigation* (ISBN: 9780819423436); John Hicks, Peter R. De Forest, Vivian M. Baylor, editors.
7. A true and correct copy of the Proceedings Paper accompanies this declaration as Attachment A.

I declare under penalty of perjury that the foregoing statements are true and correct to the best of my knowledge.

Executed on: 1 September 2017 By: 

ATTACHMENT A

(True and Complete Copy of the Proceedings Paper follows this Cover Page)

PROCEEDINGS OF SPIE

SPIDigitalLibrary.org/conference-proceedings-of-spie

Chemical characterization of fingerprints from adults and children

Michelle V. Buchanan
Keiji Asano
Arthur Bohanon

Chemical characterization of fingerprints from adults and children

Michelle V. Buchanan^a, Keiji Asano^a, and Arthur Bohanon^b

^aChemical and Analytical Sciences Division, Oak Ridge National Laboratory,
P.O. Box 2008, Bldg. 5510, Oak Ridge, TN 37831-6365

^bKnoxville Police Department, 800 Church Ave., Knoxville, TN 37915

ABSTRACT

The observation that the fingerprints of children disappear from surfaces more quickly than those of adults initiated a study to characterize the chemical components in fingerprints. Samples were obtained from about 50 individuals ranging in age from three to 64 by extracting chemicals from the fingertips using rubbing alcohol. Using combined gas chromatography/mass spectrometry, a wide range of compounds were identified. It was found that the chemical compositions of fingerprints were quite different in children and adults. In general, the samples obtained from children contained higher levels of relatively volatile free fatty acids. Samples from adults were found to have higher concentrations of less volatile long chain esters of fatty acids. These esters are thought to originate from sebaceous glands located on the face and the levels of these compounds increase substantially after puberty. In addition to these compounds, a variety of other compounds were observed that could be used to develop improved methods for fingerprint detection at a crime scene. Further, the observation of specific compounds raises the possibility of being able to identify personal traits (gender, habits, diseases, etc.) via the analysis of components in fingerprints and/or skin.

Keywords: fingerprints, chemical analysis, gas chromatography/mass spectrometry

1. INTRODUCTION

In July 1993, a three-year-old girl was abducted and brutally murdered in Knoxville, TN. The suspect initially confessed, but later recanted his confession. This made it imperative that evidence linking the child to the suspect be found. Despite witnesses placing the child in the suspect's vehicle, a thorough examination of the vehicle did not yield any fingerprints from the child; only the suspect's fingerprints were found. This same phenomenon was observed previously in a child kidnaping where the vehicle could not be examined for prints until four days after the crime.

This raised the possibility that the fingerprints from children did not last as long on surfaces as fingerprints from adults. After contacting fingerprint experts from several agencies in this country and abroad, no information about the disappearance of children's fingerprints from surfaces could be found. To test out this possibility, a simple experiment was conducted. In August 1993, children were asked to deposit fingerprints on the inside of a number of vehicles. Within 24 hours, no fingerprints could be found. As a follow-up, a group of children and adults were asked to touch the outside surfaces of new, clean plastic and glass soda bottles, which were placed in cases. Half of the cases were stored in a basement at relatively constant temperature and humidity levels. The other half were placed in the back of an automobile, which was subjected to a range of temperatures, including summer temperatures of greater than 85°F. Samples were tested by conventional dusting over a several day period. It was discovered that the children's fingerprints disappeared within 24 hours, while the prints from adults lasted at least several days. Further, the fingerprints from bottles in the basement lasted much longer than the ones in the cars. These samples were collected every 30 days for the entire year of 1994 and similar results were observed each time. The only difference observed was that the children's fingerprints disappeared faster at higher temperatures.

Further author information:

M.V.B. (Correspondence): Email: buchananmv@ornl.gov; Telephone 423-574-4868; FAX 423-576-8559

K.A.: asanokg@ornl.gov; Telephone 423-574-7469; FAX 423-576-8559

A.B.: Telephone 423-521-1209; FAX 423-521-1205

The relationship between the disappearance of the fingerprints and temperature suggested that there was a difference in the chemical composition of fingerprints between adults and children. Literature searches showed very little information on the chemical composition of fingerprints and nothing on the fingerprints of children. A study was therefore initiated to analyze the components in the fingerprints of children and adults to ascertain if an explanation for the faster disappearance of children's fingerprints could be obtained.

2. EXPERIMENTAL

2.1 Sample preparation

Volunteers ranging in age from three to 64 were asked to submit samples. The sampling protocols were reviewed and approved by the Oak Ridge National Laboratory/Oak Ridge Associated Universities (ORNL/ORAU) Committee for Human Studies prior to initiating this study. Approximately 1 mL of rubbing alcohol (70% isopropanol in water) was placed in a small (4 mL) sample vial sealed with a Teflon-lined screw closure. The vials were cleaned prior to use by sonicating in acetone for 10 minutes and dried at 100°C for a minimum of one hour. To obtain a sample, the subject placed a fingertip on top of the vial and shook the rubbing alcohol against the fingertip for one minute. In some instances, the subject was asked to wipe the tips of the fingers across his/her forehead prior to shaking the sample vial against the fingertip. The vials were labeled by a code number to protect the identity of the subject. Prior to analysis, the samples were concentrated under a small stream of argon gas until approximately 50 to 100 μ L of solution remained. Some samples were analyzed directly at this stage. Others were derivatized using a methylating reagent to allow polar compounds to be analyzed more readily. In this case, 100 μ L of Methyl-8[®] reagent (Pierce Chemical Company, Rockford, IL) was added to the concentrated sample solution. The vial was then heated for 20 minutes at 60°C and the sample was then ready for analysis.

2.2 Sample Analysis

The samples were analyzed on a combined gas chromatograph/mass spectrometer consisting of a Varian 3400 gas chromatograph interfaced to a Finnigan ITS40 quadrupole ion trap mass spectrometer. A fused silica capillary column, 30 m in length and 0.25 mm ID with a bonded (5%-phenyl)methylpolysiloxane stationary phase (DB-5, J&W Scientific, Folsom, CA) was used to separate the components prior to analysis in the mass spectrometer. Helium was used as the carrier gas at a head pressure of 5 psi. The injector temperature was held at 280°C and the column oven was temperature programmed, starting at 100°C for one minute and ramping at 5°C/min to 280°C, where the column was held up to 30 minutes. The mass spectrometer transfer line was maintained at 280°C and the manifold heater for the analyzer cell was maintained at 220°C. All mass spectra were obtained using electron ionization (70 eV). In some cases, chemical ionization spectra were obtained using isobutane or methane as a reagent gas to verify molecular weights of the observed compounds. In this case a Hewlett-Packard 5985 GC/MS, equipped with a similar chromatographic column and operated under similar chromatographic conditions, was employed. The reagent gas was introduced into the ion source at approximately 0.5 torr and the chemical ionization plasma was formed using 200 eV electrons.

3. RESULTS AND DISCUSSION

During the course of these studies, nearly fifty subjects were studied, with about half ranging in age from three to 13 years and the other half, from 15 to 64 years. The chromatographic profiles obtained from the samples clearly fell into two classes, one made up of prepubescent children and the other from adults. The total ion chromatogram shown in Figure 1 is taken from a four year old boy and is typical of the profiles obtained from children. The early eluting peaks are composed primarily from long chain carboxylic acids having from twelve (C_{12}) to more than twenty-six (C_{26}) carbons, including palmitic and stearic acids. Because the samples were methylated, these compounds were detected as methyl esters of the acids. These compounds clearly are the major components in the samples obtained from children. Figure 2 is a total ion chromatogram obtained from an adult male (age 27). This chromatogram is quite distinct from the one in Figure 1 and is quite typical of those obtained from adults. In this profile, long chain carboxylic acids are also observed, but at a much lower level than in the samples from children. However, a number of higher molecular weight compounds are also observed at retention times greater than 50 minutes. These compounds, which are not observed in the child's profile in Figure 1, are long chain alkyl esters of carboxylic acids, such as C_{16} esters of C_{18} acids. General structures of the long chain carboxylic acids and esters are given in Figure 3.

Samples taken after the subject had wiped his/her forehead revealed even larger amounts of the long chain alkyl esters. These esters are members of a class of compounds called lipids. Most of the lipids on skin are thought to originate from sebaceous glands¹ and the highest density of these glands occur on the scalp and face, with none on the palms. Because an individual frequently touches his face and hair, it is logical that this material is transferred to the fingertips and can be found in fingerprints. Further, in adults, it is thought that over 95% of the skin surface lipids arise from sebaceous excretions.² The surface lipids in children, on the other hand, are thought to arise from the

Explore Litigation Insights

Docket Alarm provides insights to develop a more informed litigation strategy and the peace of mind of knowing you're on top of things.

Real-Time Litigation Alerts



Keep your litigation team up-to-date with **real-time alerts** and advanced team management tools built for the enterprise, all while greatly reducing PACER spend.

Our comprehensive service means we can handle Federal, State, and Administrative courts across the country.

Advanced Docket Research



With over 230 million records, Docket Alarm's cloud-native docket research platform finds what other services can't. Coverage includes Federal, State, plus PTAB, TTAB, ITC and NLRB decisions, all in one place.

Identify arguments that have been successful in the past with full text, pinpoint searching. Link to case law cited within any court document via Fastcase.

Analytics At Your Fingertips



Learn what happened the last time a particular judge, opposing counsel or company faced cases similar to yours.

Advanced out-of-the-box PTAB and TTAB analytics are always at your fingertips.

API

Docket Alarm offers a powerful API (application programming interface) to developers that want to integrate case filings into their apps.

LAW FIRMS

Build custom dashboards for your attorneys and clients with live data direct from the court.

Automate many repetitive legal tasks like conflict checks, document management, and marketing.

FINANCIAL INSTITUTIONS

Litigation and bankruptcy checks for companies and debtors.

E-DISCOVERY AND LEGAL VENDORS

Sync your system to PACER to automate legal marketing.