Department of Chemistry,
Materials and Forensic Science
Centre for Forensic Science

Metal deposition techniques for the detection and enhancement of latent fingerprints on semi-porous surfaces

Naomi Jones

Doctor of Philosophy (Science)
2002

Proverbs 1:7
The fear of the LORD is the beginning of knowledge
(Holy Bible, New International Version)

To the glory of God, the source of all knowledge and truth

With gratitude to those who have encouraged and aided me in searching after the truth

Certificate of Authorship and Originality

I certify that the work in this thesis has not previously been submitted for a degree nor has it been submitted as part of the requirements for a degree except as fully acknowledged within the text.

I also certify that the thesis has been written by me. Any help that I have received in my research work and the preparation of the thesis itself has been acknowledged. In addition, I certify that all information sources and literature used are indicated in the thesis.

Production Note:
Signature removed prior to publication.

Naomi Jones

5th July 2002

Acknowledgments

The assistance of many people has contributed to success of this work.

Firstly, my thanks go to Mr Milutin Stoilovic and Dr Chris Lennard. It has been a pleasure to work along side you for the last 3 years. Your knowledge and experience in the field of fingerprint development, your willingness to share this and enthusiasm for our research have been invaluable.

Also to Associate Professor Claude Roux. Thanks for your continual encouragement and for ensuring that things ran smoothly.

To the honours students who worked with me- Ms Danielle Mansour, Ms Megan Kelly and Ms Karla Kiprovic- each of your work has been of great value to me.

The support of Forensic Services Australian Federal Police, and the director Dr James Robertson, for my project has been of great benefit. I would especially like to thank the Criminalistics Team (David Royds, Ben Kwok, Sarah Benson and Cathy Carey) who made me a pseudo-team member long before I actually was.

The assistance of the Reserve Bank of Australia and Note Printing Australia in the provision of banknote samples and information and advice on the polymer banknotes has been invaluable. In particular I would like to thank Ms Elaine Kerrison (Note Issue Department, RBA), Mr Philip McMahon (previously of NPA) and Mr Wayne Jackson (Research & Development Department, NPA).

Advice from Dr Bertrand Schnetz (Forensic Services, Jura Police Service, Switzerland) and Dr John Brennan (Forensic Science Service, UK) in relation to MMD is gratefully acknowledged.

Staff of the Faculty of Science at the University of Technology are also acknowledged for their technical assistance: Mr Jim Keegan (ICP-MS), Mr Geoff McCredie (XPS) and Dr Richard Wuhrer (SEM)

Dr Roger Netterfield (Telecommunications and Industrial Physics, CSIRO) is also acknowledged for his assistance in understanding thin gold films.

My final thanks go to my family and friends, especially Mum & Dad, Deb, Lois & Andrew and Mandy, whose personal support and encouragement has been, and continues to be, most important and appreciated.

Abstract

Fingerprints can provide critical evidence in the investigation of crime. Most fingerprints are latent, or invisible, and hence need detection and enhancement before they can be used in the investigation of crime.

While techniques exist for fingerprint development on a range of surfaces, the detection of prints on semi-porous substrates is particularly difficult. Vacuum metal deposition (VMD) and multi-metal deposition (MMD) were investigated for their ability to detect latent prints on such surfaces.

VMD is recognised as a very sensitive method of latent print visualisation but inconsistent results are commonly encountered. This research shows that reproducible VMD development is only obtainable when the amount of gold deposited is carefully controlled. The type and quality of VMD development obtained is influenced by a number of critical factors. These factors include the amount of gold deposited, the polymer type of the surface being treated, the nature of the latent print itself, and the presence of any other contaminants on the surface (whether due to the history of the exhibit or treatment with other fingerprint reagents).

MMD has not found routine application due to its complexity and mediocre results. Recent research that sought to overcome these problems resulted in the development of a new formulation known as MMDII. Several MMD formulations were trialled in this study and MMDII proved to be the superior formulation, giving better overall print detail. On non-porous surfaces, MMDII may offer further print development than that achieved with cyanoacrylate fuming (CAF) and luminescent staining, but VMD always gave superior results to MMD.

Polymer banknotes are a difficult semi-porous surface, causing particular problems for fingerprint laboratories. A procedure utilising CAF followed by VMD and finally luminescent staining enables successful print development on this substrate. Success on new notes was achieved with prints up to 18 months old; unfortunately, the possibility of successful print development decreases on used banknotes. VMD has

two important advantages for print visualisation on polymer notes: i) it is sensitive enough to detect the small amounts of residue remaining; and, ii) the zinc layer removes a significant amount of interference caused by the banknote design.

MMD and VMD were compared to standard techniques on other semi-porous surfaces. MMD proved to be the technique of choice on these surfaces. The ability of MMD to react with print residue within and on the surface is believed to be important to its success.

Table of Contents

List of Figures

List of Tables

Abbreviations

AFM = Atomic Force Microscope or Microscopy

AFP = Australian Federal Police

APD = Average Particle Diameter

ASAP = Automatic Standardless Analysis Program

CA = Cyanoacrylate

CAF = Cyanoacrylate fuming (or superglue fuming)

CV = Co-efficient of variation

DFO = 1,8-diaza-9-fluorenone

DNA = Deoxyribose Nucleic Acid

DOVD = Diffractive Optically Variable Device

DMAC = 4-dimethylaminocinnamaldehyde

ESCA = Electron Spectroscopy for Chemical Analysis

FFC = Forensic Fuming Cabinet

FT-IR = Fourier Transform- Infra-Red Spectroscopy

HDPE = High-density polyethylene

Hq = Hydroquinone

ICP-MS = Inductively coupled plasma-mass spectrometry

IR = Infra-red Radiation

LDPE = Low-density polyethylene

MEK = Methyl ethyl ketone

MMD = Multi-metal deposition

MMDI = Original MMD formulation

MMDII = New MMD formulation

MMDIII = MMD formulation used by Forensic Science Service UK

MMDIV = Fourth combination of MMD reagents

NPA = Note Printing Australia

PD = Physical developer

PE = Polyethylene

PET = Polyethylene terephthalate

PP = Polypropylene

PVC = Polyvinyl chloride

RBA = Reserve Bank of Australia

SEM = Scanning Electron Microscopy

UV = Ultra-Violet Light

VCAF = Vacuum cyanoacrylate fuming

VMD = Vacuum metal deposition

XPS = X-ray Photoelectron Spectroscopy

XRF = X-Ray Fluorescence Spectroscopy