DEVELOPMENT OF A FORENSIC GLASS DATABASE SYSTEM EMPLOYING REFRACTIVE INDEX MEASUREMENT

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Dedicated to:

My lovable parents, Asmuje @ Asmuzi bin Ihwan @ Ahwan, my dearest sibling, not forget my supportive colleagues, AP Dr. Umi Kalthom Ahmad, Dr Roliana Ibrahim and Puan Nor Umizza Kamaruzaman

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ABSTRACT

Burglary and accident cases may involve glass fragments as physical evidence found at the crime scene. In forensic investigation, the purpose of glass analysis is to determine the origin of unknown glass. The common analysis of glass is physical examination which is thickness and color identification; and refractive index (RI) measurement as major examination. Currently, a compilation of refractive index (RI) or glass database on RI values of glass found in Malaysia is desirable and much needed by the forensic chemist. In this study, twenty samples of glass each from automobile glass, building glass and household glass were collected from various sources. Physical examination such as thickness and color were done to obtain preliminary information of the glass samples. The thickness of the glass for three classifications which is building, automobile and household according to end-use was in the range of 2-6 mm. For glass color, clear transparent was found to be commonly used in glass manufacturing followed by green, white, grey, blue and bronze colored glass. Determination of RI value was affected using Glass Refractive Index Measurement 3 (GRIM3) instrument. The classification of end-use types of glass by relating RI value and thickness of automobile glass showed 3 clusters corresponding to windscreen glass (1.5152 – 1.5225), rear screen glass (1.5147-1.5217) and side window glass (1.5188-1.5190), all samples with thickness of between 2 – 6 mm. While, building glass can be classified into heat absorbing float (1.5197 – 1. 5211), clear float (1.5189 – 1.5213), figured float (1.5164 – 1.5234) and reflective float (1.5167 - 1.5188) with sample thicknesses of 2 – 6 mm. Household glass can be classified into 2 clusters. The first cluster consisted of bulb and lamp cover glasses with thickness of between 2 - 4 mm and covered a wide RI range of 1.5133 – 1.5244 while the second cluster is comprised of bottles and decorative glasses that covered a small RI range of 1.5200 – 1.5218 and larger glass thickness of between 4 – 5 mm. All informations obtained in glass analysis were used for forensic glass database. It was developed using Microsoft SQL Server Management 2008 and Microsoft Visual Studio 2008. My Forensic Glass Database System version 2011 contained 60 records of glass. It used the thickness, colors and RI values of a glass fragments to match with those stored in the database.

ABSTRAK

Serpihan kaca merupakan bukti fizikal selalunya ditemui di tempat kejadian jenayah terutamanaya bagi kes pecah rumah dan kemalangan jalan raya. Dalam penyiasatan forensik, analisis kaca dilakukan adalah bertujuan untuk menentukan asal serpihan kaca tersebut. Analisis kaca yang biasa dilakukan ialah pemeriksaan fizikal (ketebalan dan warna) dan ukuran indeks biasan yang menjadi pemeriksaan utama. Sehingga hari ini, penyusunan indeks biasan atau pangkalan data kaca yang melibatkan nilai indeks biasan kaca yang terdapat di Malaysia adalah amat diperlukan oleh ahli kimia forensik. Dalam kajian ini, dua puluh sampel kaca dari kaca kereta, bangunan dan isi rumah diperoleh daripada pelbagai sumber. Pemeriksaan fizikal seperti ketebalan dan warna telah dilakukan untuk mendapatkan maklumat awal mengenai kaca tersebut. Ketebalan kaca daripada tiga klasifikasi iaitu bangunan, kereta dan isi rumah adalah dalam lingkungan 2-6 mm. Sementara itu, warna yang sering digunakan dalam pembuatan kaca adalah lutsinar diikuti oleh hijau, putih, kelabu, biru dan gangsa. Penentuan nilai indeks biasan diukur menggunakan instrumen “Glass Refractive Index Measurement 3 (GRIM3)”. Pengelasan kaca menurut penggunaaanya dilakukan dengan menghubungkan nilai indeks biasan dan ketebalan kaca dapat menunjukkan 3 kelompok automobil iaitu cermin skrin hadapan (1.5152-1.5225), skrin belakang (1.5147-1.5217) dan tingkap (1.5188-1.5190) di mana semua sampel mempunyai ketebalan antara 2 - 6 mm. Selain itu, kaca bangunan boleh dikelaskan kepada “heat absorbing float” (1.5197 – 1. 5211), “clear float” (1.5189 – 1.5213), “figured float” (1.5164 – 1.5234) dan “reflective float” (1.5167 - 1.5188) dengan sampel ketebalan dari 2 - 6 mm. Kaca isi rumah dapat diklasifikasikan kepada 2 kelompok. Kelompok pertama mengandungi kaca mentol dan penutup lampu dimana ketebalannya diantara 2 – 4 mm dan mempunyai kadar indeks biasan yang besar iaitu 1.5133 – 1.5244, manakala kelompok kedua terdiri daripada kaca botol dan hiasan yang meliputi kadar indeks biasan yang kecil iaitu 1.5200 – 1.5218 dan ketebalan diantara 4 – 5 mm. Semua maklumat yang diperolehi dalam analisis tersebut digunakan untuk pembangunan pangkalan data kaca forensik. Ia dibangunkan dengan menggunakan Microsoft SQL Server 2008 dan Microsoft Visual Studio 2008. Sistem “My Forensic Glass Database” versi 2011 terdiri daripada 60 data tentang kaca. Ia menggunakan ketebalan, warna dan nilai indeks biasan sesuatu serpihan kaca untuk mendapatkan padanan kaca yang terdapat di dalam pengkalan data.

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LIST OF ABBREVIATION

ABS	-	Air Bag System
Al	-	Aluminum
Al_2O_3	-	Aluminium oxide
Ba	-	Barium
Ca	-	Calcium
DBMS	-	Database Management System
DNA	-	De-oxyribo Nucleic Acid
Fe	-	Iron
GB	-	Gigabyte
GHz	-	Gigahertz
GRIM	-	Glass Refractive Index Measurement
IC	-	Identity Card
ICP-AES	-	Inductively Coupled Plasma - Atomic Emission Spectroscopy
ID	-	Identification Code
IDE	-	Integrated Development Environment
JKM	-	Jabatan Kimia Malaysia
LA-ICP-MS	-	Laser Ablation Inductively Coupled Plasma Mass Spectrometry
Low-E	-	Low-emissivity
Mg	-	Magnesium
MgO	-	Magnesium oxide
mm	-	Millimeter
Na_2O	-	Sodium oxide
nm	-	Nanometer
RAM	-	*Random-Access Memory*
RDD	-	Rapid Application Development
RI	-	Refractive Index

SD	-	Standard Deviation
SEM-EDX	-	Scanning Electron Microscopy-Energy Dispersive X-ray Spectroscopy
SiO_2	-	Silica
Sr	-	Strotium
SQL	-	Structured Query Language
Ti	-	Titanium
UV	-	Ultraviolet
VB	-	Visual Basic
XRF	-	X-ray fluorescence
Zr	-	Zirconium

LIST OF SYMBOLS

°C	-	Degree Celsius
%	-	Percent

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1	2nd International Forensic Science Symposium	75

CHAPTER 1

INTRODUCTION

1.1 Research Background

Locard's exchange principle "Every Contact Leaves a Trace" has become the heart for the basis in forensic investigation. Whenever there is a contact between persons and environment, they will leave or take something from the scene (Saferstein, 2011). Therefore, it is important for forensic scientist to examine the crime scene carefully for any clues or physical evidence that may establish links between crime scene, victim, and perpetrator.

A myriad of physical evidence are often sent to forensic laboratory for examination before being presented in the court. The evidences that are usually found at the scene are drug, cloth fibers, firearms, tool marks, blood stains, body fluids, glass fragments, seminal stains, paint, explosive and others (Girard, 2011). In cases involving accidents or house breaking, glass fragments are often submitted for forensic analysis. The Department of Chemistry Malaysia reported 69 glass samples received since 2006 (Minhad, 2011).

The value of glass depends on its properties and composition. Glass may be taken or left either in large piece or in tiny fragments. Particles of glass may be found on the clothing of an alleged burglar where entry was through a broken window. Glass fragmentation may also become as evidence when found on alleged driver of a hit-and run cases or when a glass bottle was used as a weapon (Miller, 1982).

1.2 Problem Statement

Refractive index (RI) measurement is the most common method employed for glass analysis. Measurement is typically made on all samples of recovered fragments and on a sample of fragments from control glass (Newton *et al.*, 2008). However, if the control glass sample was not submitted to the laboratory, the case may unsolved due to lack of clues regarding its origin. RI values are different depending on the types of glass, thickness and manufacturer. A compilation of refractive index (RI) or glass database on RI values of glass found in Malaysia is desirable and much needed by the forensic chemist. Currently, no such database exists in order to assist the forensic analyst for glass comparison.

1.3 Objective of Study

This study embarks on the following objectives:

i. To analyze different types of glass using RI measurements.

ii. To classify glass according to end-use by relating RI value with glass thickness.

iii. To develop a glass database system for comparison of glass samples from crime scene with sample of known glass manufacturers based on refractive index of glass.

1.4 Scope of the Study

In this project, three types of glass namely building glass, automobile glass and household glass from various manufacturers were analyzed. Physical properties

such as thickness, color and refractive index of the glass were determined. The refractive index measurements employed an immersion method employing hot stage microscope using Glass Refractive Index Measurement (GRIM) instrument. A glass database system was developed using Microsoft Visual Studio and Microsoft SQL as a server.

1.5 Significance of Study

Results of this study will be of assistance to forensic chemists working in government laboratories such as Department of Chemistry Malaysia, private forensic consultant and Royal Malaysia Police where comparison of case samples require a good match with that of standard samples stored in the glass database. It is also useful in cases where control glass samples were not submitted or unavailable for comparison with case glass fragments.

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