9.1 Overview

Examinations of ink can involve many facets. Limitations can be placed upon these examinations by influences such as the type of ink, substrate, the type of analysis requested, etc. Ink examinations are conducted utilizing microscopy and instrumentation to discriminate between ink formulations. Limited chemical analysis of ink may be employed in further attempts to discriminate ink formulations. Information provided below gives an overview of the process, considerations and instrumentation used. Analysis schemes for each case will be implemented depending upon the type of evidence presented.

9.2 Instrumentation

9.2.1 Wild Heerbrug Stereo Microscope Users Manual

9.2.2 Doya Video Analyzer Users Manual

9.2.3 VSC 6000 Users Manual

9.2.3.1 VSC 6000 Function Verification

The VSC 6000 is a self-calibrating instrument that is designed not to function if the self-calibration file is unsuccessful during instrument startup. For purposes of this procedure to verify the instrument is functioning, a function verification will be conducted prior to conducting casework examinations on forensic document evidence. This function verification is to verify the function of the detection of absorption, transmission and luminescence of infrared and ultraviolet energy. The result of the function verification will be recorded in a function verification log kept near the VSC in the instrument room. In the event of a an instrument failure, the QD Unit Supervisor will be notified immediatey and the instrument will be taken out of service by placing a sign or some method of notifying other examiners the instrument is non-functional. The the instrument will remain off-line until it is repaired and restored to proper function.

1. Start VSC and place two five euro notes supplied by the vendor (in an envelope in the three ring binder near the instrument) so they are visible in the machine. Do not change any settings at this point.

2. Open Image 1 from Function Check folder on the Desktop of the VSC 6000 computer (using the following commands in the VSC6000 software; File, Image, Open). When asked if you want to restore settings, click “Yes.”

3. Change the view (center of top menu) to Live + Stored. Using the two Euro bank notes, compare the stored image with the live image to ensure the instrument’s responses to the document properties in the live and stored images appear the same.

4. Close stored image.

5. Repeat these steps with Images 2 and 3

6. Upon completion of function check, complete log indicating the instrument was functioning properly on the date of the examinations.

7. In the event of a failure during any of the function checks, the unit is to be taken out of service by placing a sign on it and notify the QD Unit Supervisor.

9.3 Electromagnetic Spectrum

9.3.1 Infrared Absorption

Absorption - infrared radiation is absorbed by organic molecules and converted into energy of molecular vibration. In IR spectroscopy, an organic molecule is exposed to infrared radiation. When the radiant energy matches the energy of a specific molecular vibration, absorption occurs.

9.3.2 Infrared Transmission

Transmission - the process whereby radiant flux passes through a material or object without a change in wavelength of its monochromatic components.

9.3.3 Infrared Luminescence

Luminescence - the emission of radiant energy during a transition from an excited electronic state of an atom, molecule or ion to a lower electronic state.

9.4 Optical Filters

Optical filter - a device which selectively transmits light having certain properties (often, a particular range of wavelengths, i.e. colors of light, or polarizations), while blocking the remainder. (Source:http://www.wordiq.com/definition/Optical_filter)

9.4.1 Definitions

Term	Symbol	Definition
Absolute Blocking		The region outside the pass band where no peaks or spurious responses are permitted above a specified level. Expressed in terms of optical density or transmission, e.g., 10-4, 4.0 OD, etc.
Angle of Incidence		The angle of incident energy arriving at the surface of the filter. Expressed in degrees off normal.
Angstrom	Å	10 to the -10th meters.
AR Coating		An optical coating of one or more layers used to reduce the surface reflection of a substrate (glass, quartz, etc.).
Average Blocking		The region outside the pass band where the average energy is not permitted to exceed a specified level. Expressed in terms of optical density or transmission, e.g., 10-4, 4.0 OD, etc.

Bandpass filter		An arrangement of optical thin films on multiple substrates that allows passage of energy within a specified bandwidth, while rejecting all energy outside the specified bandwidth.
Bandwidth	HBW FWHM	Bandwidth is the spectral region where the interference patterns are constructive and is defined in terms of the wavelength of the upper half power point minus the lower half power point in nm. It is often described as HBW (half band width) or FWHM (full width at half maximum).
Blocking		Rejection of energy outside the bandpass of a filter. Expressed as a ratio of peak transmittance of the bandpass filter to the off-band energy over the range of the intended detector. Expressed in terms of a transmission ratio (.0001 T, 10-4 T, Optical Density, etc.). Same as off band rejection.
Cavity		Basic building block of the interference filter. Each cavity is a single tuned element in the filter. By combining cavities, in series, the shape of the pass band can be altered appreciably. Increasing the number of cavities results in a more square shape of pass band. Bandwidth is also affected by the number of cavities; the greater the number of cavities, the wider the bandwidth. Expressed as the number of cavities in a particular filter (two cavity filter, three cavity filter, etc.).
Central Wavelength	**CWL**	The wavelength determined by arithmetic mean of the two wavelengths used to determined bandwidth. Expressed in terms of a fraction of a meter, nanometers (10-9 m), angstroms (10-10 m), and microns (10-6 m).
Clear Aperture	C.A.	The actual usable area of a filter, usually less than the size of the filter. Expressed in terms of diameter or rectangular dimensions.
Combined Filter/Detector		A combined filter/detector incorporates both an interference filter and a silicon detector in the same housing.
Infrared	IR, NIR, FIR	Energy in the spectrum from 700nm to beyond 50,000nm. Often broken down into categories such as near (NIR) and far (FIR), etc. Expressed in terms of wavelength for near infrared and in terms of frequency for far infrared.
Interference Filter		An interference filter is a system of very thin coatings applied on a glass substrate in such a manner that at a specified center wavelength (CWL in nm.) the interference pattern is constructive over a small spectral region and aids in transmission of light energy while at other wavelengths the interference pattern is destructive and prevents the transmission of light energy.
Minimum Transmission	T_{min}	T_{min} is the minimum value of transmission a filter must meet.

Nanometer	**nm**	A nanometer is 10-9 meters (approximately .0000000394") and is the unit usually used to measure light energy in the optical spectrum. The color green has a nominal CWL of 550 nanometer meaning that it is 550nm in distance between wave crests of the incident energy.
Off Band Rejection		Same as Blocking. The absolute value of transmission at any wavelength outside of the pass band. It is often expressed in units of transmission (10-4 being 0.01%T) or in optical density (O.D.) units, O.D. = Log 1/T or in decibels, DB = 10Log1/T.
Optical Density	**OD**	Reciprocal of transmission expressed in logathrimic terms. Formula: OD=Log10(1/T).
Peak Transmission	Tp	Tp often occurs at some wavelength different than the specified CWL, but still within the pass band of the filter.
Peak Wavelength	**%Tpk**	The wavelength of peak transmission, often slightly different than center wavelength (CWL). Expressed in terms of wavelength.
Photo Diode		A photo diode is a device that converts incident photons to electrical energy, usually electrical current. Intor's combined filter/detectors use a Silicon photo diode which when used in the photovoltaic mode produces an electrical current proportional to the incident light (photons).
Transmission	**%T**	Ratio of the output energy of a filter to its input energy. Expressed in terms of percentage.
Ultraviolet	UV	Energy in the optical spectrum between 200 and 400 nm. Expressed in terms of wavelength.
Visible	**VIS**	Visible is the part of the optical spectrum where the human eye responsive. Energy in the optical spectrum between 400 and 700 nm. Expressed in terms of wavelength.

(source: http://www.intor.com/OpticsClassroom/glossary.html)

9.4.2 Barrier

A barrier filter is positioned between the specimen and the capture device and is used to tune or filter specific wavelengths of energy.

9.4.3 Long Pass

Long pass filters are interference filters which provide a sharp cut-off either above or below a particular wavelength. They are useful for isolating specific regions of the spectrum.

9.4.4 Excitation

Energy (light) is passed through optical excitation filters which allow only a specific wavelength range of light to reach the item being examined. These are used in various instruments to examine ink and paper specimens.

9.5 Chemical Removal of Inks

This procedure is used to remove certain inks which may be obliterating other writings or typing; usually after exhausting all non-destructive techniques. The submitting agency shall be contacted for approval prior to applying this procedure. A spot test should be run to make sure it will not remove all inks or typing on the document.

9.5.1 Materials needed:

Chloroform.

Citric Acid.

Bleach solution (common house hold).

9.5.2 Directions:

Swab the markings well with chloroform and allow to dry.

Saturate by swabbing with citric acid and allow to dry.

Swab with bleach solution.

If this works, the ink will be removed.

Sometimes just the use of the bleach will remove the ink.

9.6 Ink Dating Requests

The MSP Questioned Document Unit does not conduct chemical ink analysis to determine the age an ink entry on a document. Requests of this type will be referred to an appropriate external laboratory (primarily the U.S. Secret Service or the U.S. Department of Treasury or the Internal Revenue Service).

REFERENCE

Lansing Laboratory QD Unit MSDS

NIST Special Publication SP250-69 - Appendix A

The Electromagnetic Spectrum - Chapter 15 - Online Edition - University of Colorado, Boulder, Dept. of Chemistry and Biochem (2002)

ASTM International:

E1422 Standard Guide for Test Methods for Forensic Writing Ink Comparisons
E2195 Standard Guide for Writing Ink Identification
E2389 Standard Guide for Examination of Documents Produced with Liquid Inkjet Technology