



## Forensic Examination of Paint

### KEYWORDS

Paint, Binders, Pigments.

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**ABSTRACT** *Paint is found as trace evidence. The paint is obtained from the scene of crime in number of ways depending upon the mechanism of contact and nature of the surface. The paint is found either in chip or smear form. The paint as trace evidence is obtained in vehicular accidents, hit and run cases, theft etc. The paint can be obtained on tools, structures, vehicles or from clothing of victims from the scene of crime.*

### Introduction

Paint can be defined as a material used for the purpose of coating the surface. The aim of application of paint on the substance is to protect them from external factors such as moisture, heat, oxygen of air, snow, rain and ultraviolet radiation. Also the paints are applied to hide the old paint or to hide the dents or any damage if present such as scratches, abrasion. The paint is applicable to the substances such as wood, metals, plastics etc. The paints are also used for the purpose of decoration. The different types of paints that are used commonly are Oil paints, Varnish, Enamel, Latex Paint, Water-Reducible Paints, Alkyds, Automotive paints, Epoxy Paints, Polyester-Epoxy paints, Acrylic-Epoxy paints, Shellac, Aluminium paint, Acrylic-Urethane coatings etc.

The paint has variety of components. Each component have different role. The principal components of paints are pigments, binders, solvents and additives. The majority of the components of paints are organic in nature along with inorganic components. The paint in forensic science are analysed for these components for the identification. The examination of paint is carried out by studying its physical and chemical properties.

### Composition of Paint

#### Pigments:

Pigments are organic or inorganic in nature. They are ground- particles. The main function of pigment is to impart colour, opacity and gloss. The pigments are dispersed in a solvent. The pigments can be red, black, white, yellow and blue. Organic pigment belongs to class of azo compounds such as mono-azo compounds, di-azo compounds, azo metal complex etc. Inorganic pigments include carbon black, titanium dioxide, iron oxides, chromium oxides etc.

#### Binders:

The binders are the substance that holds pigment to the surface. Binders can be obtained naturally from vegetable oils, resins, gums etc. or are synthesized chemically. The binders introduce properties like resistance to corrosion, flexibility, hardness and protection to U.V radiation. The different types of binders are drying oils, alkyd resins, vinyl emulsions, epoxy resins etc.

#### Solvents:

Solvents are substances that are used to make binders soluble but it should not get polymerize. For resins many organic solvents are used but commonly used is turpentine. The solvent provides viscosity to paints. Solvent makes the application of paint easy to substrates. Solvents like alcohols, water, ketones, terpenes, esters, aromatic hydrocarbons etc. are used in paints.

#### Additives:

These substances are added in small quantities to paint.

The additives are mixed to carry out special jobs, such as improvement of surface appearance. The substances can be plasticizers, absorbers etc. The most commonly used plasticizers are diethyl phthalate and dibutylphthalate.

#### Automotive Paints:

The paint coat of the body of a vehicle consists of number of successively layers. These differs each other from their ingredients. The paint differs with car and the brands. The paint coverings on renovated car have more number of layers. The identification and comparative studies of paint chips are done by studying its morphology. The more number of layers, more numbers of features can be studied.

#### Analysis of Paint

In Forensic Science, the aim of paint analysis is to find its source of origin by comparing the questioned sample with the standard. The paint can be found from any sources present on scene of crime such as tools, walls, glass and glass fragments, fingers, nails, roads, motor vehicles etc. for the better analysis and good results the proper sample should be available. For the collection of samples proper equipments should be used such as sharp edge knife for scraping, white paper funnels for the chip collection, sealing of paint chip in container etc. The samples can be obtained from the areas like wall, ceiling, door, window, automobile door etc. The known samples collected should have all layers of undamaged paint film. The known samples should be packaged carefully. Sometimes paint flakes are also collected for the purpose of analysis. Paint flakes are also removed by several methods or by using instruments like blade, knife etc. or by gently impacting on opposite side of the painted surface.

#### Microscopic Techniques

Initial examination of paint is carried out by stereomicroscope. The stereomicroscope is used to determine the number, sequence, colour, thickness and texture of each layer in paint. The cross section of paint is revealed by cutting the paint chip perpendicular to the surface by using the microtone. Polarized Light Microscope is used to study the optical properties of transparent sample such as pigments using the transmitted polarized light. Polarized Light Microscopy can be used for both identification and comparison purpose. Plane polarized light is used to observe colour, pleochroism, opacity and to determine refractive index.

Fluorescence microscope is used to observe the visible fluorescence of opaque and transparent samples. Fluorescence occurs when light absorb the material is re-emitted with longer wavelength. In this microscope, light reaching the sample and light reaching the eyepiece is regulated by many filters. Many pigments, binders, coatings are fluorescent. Fluorescence microscopy is used to distinguish layers and particles that appear similar in visible light.

Scanning Electron Microscopy-Energy Dispersive X-ray Analysis is used for the qualitative analysis of the elements present in the pigments. The technique is very useful to the study the morphology of the paint. The depth from which X-rays are produced depends on beam energy, composition and density of sample and energy of X-rays. The mapping of elements across the cross section of multi-layer paint is useful in explaining the elemental distribution in paints. The SEM-EDS gives information regarding number of layers, thickness of layers, distribution and size of pigments and particles and presence of foreign substance.

### Spectroscopic Techniques

Spectroscopy is the interaction of light with the matter. The most powerful and popular technique for the examination of paint is Fourier Transform Infrared Spectroscopy. Even small samples can be easily examined by the IR spectroscopy. The technique is useful for the identification of polymer binder, pigments and fillers present in each layer of the paint. Both organic and inorganic components can be detected using the IR spectroscopy. The pigments and fillers will give small peaks in spectra. However identification of organic pigments is difficult due to their low concentration in the paint.

The X-ray Fluorescence technique is also a good technique for the paint examination. It is based on the emission of characteristic X-ray by the sample on excitation by X-ray source. The XRF gives the information of elemental data of single or multiple layers. The variation in thickness of layers may cause the variations in the X-rays ratios of element present; this technique is used for both for the purpose of comparison and qualification. The XRF is also very useful for the elemental analysis of lead in paint.

Raman spectroscopy can also be used for the identification of binders, pigments, additive and coatings. Raman spectroscopy is useful for the analysis of inorganic pigments and additives because like Far-IR spectroscopy, it can provide information about low frequency Vibrational transition. Raman spectroscopy has advantage over IR spectroscopy. The organic and inorganic pigments are infrared active but they are very difficult to distinguish as their absorptions are low. The pigments have strong absorption in Raman Spectroscopy. Raman peaks are sharp and they do not overlap unlike IR

peaks. The Raman Spectroscopy is very useful in the identification of car paints.

### Micro-chemical Test

The test is also known as solvent test. It is based on reactions of pigments and binder with the oxidizing and reducing agents. The test is destructive in nature. The test is applied to both known and questioned sample. Reactions such as layer dissolution, swelling, softening, filler effervescence, and flocculation and colour changes are noted.

### Pyrolysis Gas Chromatography-Mass Spectroscopy

Py-GC/MS is a destructive technique that uses the pyrolytic breakdown of products to differentiate the types of binders and plasticizers in paints. The total ion chromatogram also gives the information regarding the additives, pigments and impurities. The automobile paints are high complex polymer mixtures having the multiple layers of polymers. With the high complex polymers, certain substances such as oxides of metals are added to introduce the property of opacity, this make the paint samples difficult to analyse using normal techniques. The Pyrolysis of the sample decreases the polymeric content leaving behind inorganic constituents. The presence or absence of monomers helps in distinguishing the paint sample from others. The technique is also useful in determination of approximate age of paints.

### Discussion

The paint samples are mostly obtained as trace evidence. So it is advisable to first apply non-destructive techniques for the examination. For this purpose the microscopy and spectroscopy techniques are good. The SEM, Polarized Light microscope Fluorescence Microscope is very useful to study morphology of paint. The IR spectroscopy and XRF spectroscopy is useful for the determination of constituents of paints and also for the elemental analysis of lead in the paint while Raman spectroscopy is very good for the analysis of inorganic pigments and additives. The pyrolysis gas chromatography technique is very useful for the identification of binders and plasticizers however the technique is destructive in nature. The micro-chemical test is the presumptive test which can be used to determine the chemical composition of paint or presence of inorganic material presence in paint based upon the results obtained in test.

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