1.4. Modern Technologies, Technical and Criminalistic Means and Methods of Laboratory Evidence Research

In the course of forensic examinations, evidence is studied in the laboratory. The technical and forensic tools and methods of such studies differ from the tools and methods used in «field criminalistics» and for the prevention of criminal activity. The differences are due to the considerable weight and outline dimensions, the complexity of preparing the object of examination to the research and the duration of the research process.

Specific types of laboratory instruments (spectrometers, chromatographs, etc.) are designed to determine qualitative and quantitative characteristics of the objects of examination with high accuracy. After transportation, a time-consuming additional adjustments required. Such devices are used only in laboratory conditions.

A system of operations, rules, techniques and methods for the most efficient organization of forensic examinations is commonly referred to as the technology of laboratory studies of evidence (expert technology). There are organizational and research components of expert technology. The organizational component covers the organization of forensic expert activity, its scientific and methodological, material and technical and information support.

Technical and forensic tools and methods of laboratory research of evidence are used for conducting expert studies.A forensic expert is not limited in the choice of technical means, approaches and methods of investigating evidence, provided that they meet the following requirements: scientific validity, admissibility of application in legal proceedings, ethics, safety, maximum preservation of the object of examination.

Various systems of technical and criminalistic means of laboratory research of evidence are developed depending on the type of the object of examination and the nature of the expert tasks. Such

systems consist of various kinds of devices, equipment, materials, scientific techniques and methods of investigating evidence.

Technical and criminalistic means, techniques and methods of laboratory research of evidence can be divided into two groups:

1) developed and used for the needs of various fields of science. They are used in forensic examination in the same way. Most microscopes (electronic, metallographic, biological), chromatographs, spectrometers, measuring and other research equipment belong to this group;

2) specially developed for laboratory research of evidence.

By the functional criteria, the methods of laboratory studies of evidence are divided into methods for analyzing images and external structure of objects, methods for analyzing the composition and structure of materials and substances, methods for studying physical, chemical and other properties of forensic objects.

The methods of image analysis are mainly used to study traditional forensic objects - human traces, traces of tools and instruments, traces of vehicles, as well as documents, films, photo and video materials, etc. The methods of optical microscopy are the most common for analyzing the external structure of objects.

Modern microscopes are equipped with digital devices for making photos and video. They are controlled by personal computers. This facilitates the process of recording the research results. Some types of microscopes enable researchers to explore objects in polarized light, with light filters, in infrared or ultraviolet rays, to change the scale, contrast and brightness of the image.

Stereoscopic microscope with the help of two eyepieces allows us to obtain a three-dimensional image of various objects (tracks) and their individual characteristics. Comparative microscopes have a double (paired) optical system (two or four eyepieces). So you can get a flat image of the lateral surface of the bullet with the traces of the firearm bore (a flat pattern of the bullet). Research and comparison of two objects (evidence and sample) simultaneously is carried out with eyepieces and a special screen.

Ultraviolet and infrared microscopy makes it possible to carry out investigations outside the visible spectral range. Ultraviolet microscopy is used to study traces of blood and other secretions of the human body, fibers, polymeric materials, biological objects, etc. Infrared microscopy makes it possible to study the internal structure of opaque objects.

The methods of elemental and molecular analysis are used for studying the composition of materials and substances. Elemental analysis methods are used to establish the qualitative or quantitative content of chemical elements in inorganic materials. The most common methods in expert practice for analyzing the elemental composition are emission spectral analysis, laser microspectral analysis and X-ray spectral analysis.

Emission spectral analysis makes it possible to convert the inorganic component of the investigated substance (explosive, metals and alloys, petroleum products and combustive-lubricating materials, varnishes and paints, etc.) into a vapor state and to excite its emission spectrum.

With the help of a special device (spectrograph) this radiation decomposes into separate spectral lines. Qualitative emission spectral analysis is based on establishing the presence or absence of the sought elements in the obtained spectrum of analytical lines. Quantitative analysis involves measuring the intensity of spectral lines.

A laser microspectral analysis is intended for the study of microparticles and microquantities of substances, the establishment of qualitative and quantitative elemental composition of various objects without their destruction. It is based on the absorption of focused laser radiation by the object, its evaporation, excitation and ionization of the atoms of matter. Radiation decomposes into a spectrum consisting of analytical lines of individual elements.

An X-ray spectral analysis is based on the transmission of X-ray radiation through the mass of the substance under investigation and its absorption by individual atoms. Atoms get into an excited state and when they return to their initial state, excess X-radiation is emitted.

The presence of spectral lines of various elements in the radiated spectrum indicates the qualitative composition of the object's material, and their intensity - the quantitative elemental composition.

An X-ray spectral analysis is a non-destructive method and is used to study a wide range of objects (metals and alloys, soil particles, varnishes and paints, document materials, shot marks, biological objects, etc.).

The methods of molecular analysis are used to study organic substances and materials (oil products, alcohol-containing liquids, paints and polymeric materials, etc.). Chemical analytical methods, molecular spectroscopy, chromatography, etc. are used to determine the molecular composition of objects (qualitative and quantitative content of simple and complex organic substances).

Chemical analytical methods are used in the first stage of laboratory studies of toxic, narcotic and potent substances, traces of etching in documents, pharmaceutical products, explosives and other materials in order to establish their type. Qualitative analysis of traces of certain types of substances is usually carried out with the help of special sets of technical and forensic tools, which are also used in «field Criminalistics)).

Molecular spectroscopy (in the infrared, visible and ultraviolet regions of the spectrum) and chromatography are the principal methods for studying the qualitative and quantitative molecular composition of substances. Molecular spectroscopy is based on the study of the absorption, reflection and emission spectra of electromagnetic waves, as well as the luminescence spectra of the substance under study. Such studies are conducted in the wavelength ranging from ultraviolet to infrared radiation.

The methods of molecular spectroscopy are used to study polymers, plastics, petroleum products, varnishes and paints, perfume and cosmetics products and other organic materials. Spectroscopy in the visible and ultraviolet regions of the spectrum is used to establish the qualitative and quantitative composition, as well as the structure of molecules of liquid substances.

Chromatographic methods of investigation are used for qualitative and quantitative analysis of the phase composition of complex mixtures (combustible and lubricating materials, petroleum products, alcohol-containing liquids, ballpoint pen ink, drugs, food products and beverages, explosives, dyes, etc.).

The methods are based on a different distribution of components between the two phases - stationary and mobile. Gas, gas-adsorption, gas-liquid and liquid chromatography are distinguished depending on the aggregate state of the mobile phase of the substance.

The method is based on the unique distribution of atoms of chemical elements in the crystalline grids of substances of different composition. The analysis of X-ray diffraction data (X-ray diffraction) makes it possible to analyze the crystal structure of objects and establish the qualitative and quantitative phase composition of the substance.

Metallographic and X-ray analyses are used to study the crystal structure of objects. Macro- and microstructures of metals and alloys are determined by the metallographic analysis.

The method makes it possible to detect changes in the metal, depending on the chemical composition, processing conditions and the nature of the external impact. The X-ray diffraction analysis makes it possible to establish the atomic structure of the matter, measure the internal stress, and detect internal defects. The method helps to identify the effects of pressure, temperature, humidity.

The origin and the method of manufacturing car parts and mechanisms can be established on the basis of the data obtained. The structure of the short-circuit traces on electric wires indicates the cause of the fire. The structure of the metal close to the damaged gas cylinders or vehicle parts indicates the cause of the explosion or road accident.

Magnetic flaw detection methods, methods for determining microhardness, etc., are also used to study physical and chemical properties of objects under laboratory conditions.

Technical forensic means of laboratory research of evidence are constantly being improved. Means of computerization and automation of expert research allowed professionals to create automated workplaces of forensic experts specializing in various fields. They are specialized information and hardware complexes designed to automate the process of forensic investigation of a certain kind (type, subtype).

The hardware complex consists of a personal computer, external devices (scanner, printer, digital camera, etc.), various techni-

cal devices and professional equipment. The information complex consists of a set of standard and specialized programs, information systems and databases.

The databases contain visual images and descriptions of various objects and their features, standard expert methods, samples of expert opinions, normative legal acts, reference information of technical and other nature. Standard programs are designed to control the computer and devices, as well as to ensure interaction between them. Special attention is paid to the programs of automated problem solving of a certain kind (type, subtype) of forensic examination, systems of formation, editing and printing of texts, etc. An automated working environment allows to optimize the work of an expert.

The complex helps choose correctly the research methods and techniques, accurately carry out the description and classification of objects, conduct expert experiments, identify, examine, evaluate and record their specific features (including those that are not available for perception by human senses), form and print the text of the expert opinion (including - tables, photo tables, diagrams, drawings, etc.).

There are automated offices (working environments) for trace experts, ballistas, technicians, audio experts, experts in the technical document research, experts in IT research, economists, etc. Forensic experts' offices today imply special software products which closely model the real stages of expert research.

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