LETTER

New Trends in Analytical Chemistry for the Examination and Interpretation of Traces of Crimes

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Forensic sciences are generally described as the application of the scientific method to the analysis of traces in order to identify the authorship and materiality of a crime (Figure 1). Forensic scientists evaluate different types of materials, and the type of scientific method and techniques employed depend on the questions to be answered within a given context [1,2].

Forensic chemistry is one of the most far-reaching areas within the forensic science field. With the increase in technology and the development of analytical techniques, chemistry has been used more and more to elucidate legal controversies. Therefore, knowledge in chemistry is indispensable to solve crimes [3]. In this letter, the applications of analytical chemistry will be discussed within emerging forensic themes: the determination of the origin of seized drugs (chemical profiling), the investigation of document fraud, and the valuation analysis of pieces of art.

Figure 1. Techniques in analytical chemistry are used for the resolution of legal matters through the forensic sciences.

Chemical profiling consists of a series of chemical analyses that provide the concentration of the components present in the seized drugs, present as major or minor components, or even those present only in trace levels [4]. Using different analytical methods, complex chemical profiles are obtained for each drug sample analyzed, giving these samples a chemical “signature” based on the presence of impurities of natural origin and added diluents/adulterants. Therefore, such studies generate relevant data that make it possible to establish connections between samples and materials of different seizures, classifying them into chemically correlated groups. Through these connections, it is possible to establish specific links among suppliers, drug dealers, and users, designing distribution network patterns and providing subsidies for the identification of the origin of the drug, including its geographical origin [5].

Another striking forensic application of analytical chemistry is age determination and the authenticity of papers and inks. Once an ink is deposited on a support (paper), it is exposed to air, light, and moisture, and the following physical–chemical processes occur: coloration degradation, solvent evaporation,

and hardening (polymerization) of the resins. These processes have been used in the complex task of determining the absolute or relative (comparative) age of manuscripts on paper. The largest number of publications refer to ballpoint pen inks. Ezcurra and collaborators [6] published a comprehensive review on the dating of paints by modern instrument writers. Analytical paint dating exams essentially consist of quantifying how paint components vary over time [7].

Last but not least, the authentication of pieces of art used as a tool to fight crime is a recent area of activity of analytical chemistry in Brazil. Operation “Lava Jato” shed light on the possibility that criminal use of the art market is a widespread method among agents of corruption and that it is much more complex and structured than previously thought. It is up to criminal experts to determine the authenticity of a piece of art. In general, the analytical investigations are guided by the identification and quantification of substances used in the production of the art piece, using non-destructive methodologies, such as Raman spectroscopy [8].

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