J2 Determination of Physicochemical Changes in Black Ballpoint Pen by HPLC Method

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The goals of this presentation are to help attendees understand ink chemistry, ink dating, and how to best separate the ink components on a document using High-Performance Liquid Chromatography (HPLC).

This presentation will impact the forensic science community by increasing understanding of ink dating by describing the conversion and fading of ink components under environmental conditions after separation by HPLC.

Forensic document examination is an important branch of forensic science. Examination of questioned documents with suitable methods is crucial for determining the probability of document forgeries. Ink entries in the number, signature, and date on documents are the most common issues questioned by courts. Thus, ink age and structure determinations are the most frequent questions raised by the courts. Frequent questions that are asked are by whom the ink entries were written and the age of the entries.

Literature review shows that studies related with this topic in foreign countries increase day by day. Most of these studies are about the natural and artificial aging of blue ballpoint pen ink on paper. Although there are studies related to the natural aging of blue ballpoint ink, this study is a pioneer study for the artificial aging of ink entries drawn with black ballpoint pens.

Ink entries were drawn with five different black ballpoint pens and were analyzed with the help of a modified HPLC method. Fresh ink entries and ink entries exposed to light (300W) were examined during one, two, four, and six hours, respectively. A 1.2mm punching tool was used to minimize destruction while taking samples from the ink entries on the document.

As a result of six hours of light exposure, it was determined that there was formation of demethylation of the Methyl Violet (MV) family and photochemical products. It was observed that the amount of Crystal Violet (CV) decreased significantly and turned into MV and Tetramethyl Pararosaniline (TPR). It was also observed that the amount of TPR significantly increased and photochemical products formed during the artificial aging process. When the fresh ink entries were analyzed, there were no additional products observed other than CV, MV, TPR, and Victory Blue (VB). The formation of photochemical products was determined through artificial aging.

The photochemical products obtained as a result of artificial aging are evidence of whether or not a document is exposed to light. During the degradation of dyes, most of the CV turned into MV and TPR through the demethylation process. As a result of CV decomposition, the amount of MV, TPR, and other photochemical products increased significantly by means of artificial aging.

All in all, the separation of dyes in the ink formulation was completed within a shorter run time than other studies. Decomposition of dyes belonging to the MV family in black ballpoint pens was observed through artificial aging. In order to prevent document forgery, artificial aging was used to model the physicochemical processes that inks undergo while aging.

Black Ballpoint, Ink Analysis, HPLC

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