Ain Shams University
Faculty of Science
Chemistry Department

Use of image scanner as a novel sensor in the analytical laboratory

A Thesis Submitted By

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2013

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Ain Shams University
2013

Under Supervision of

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Professor of analytical chemistry

Prof. Dr. Mostafa M. M. H. Khalil
Professor of inorganic chemistry

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Approval sheet

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Eslam Hamed

Aim of work

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The current work aims at proving the ability of a conventional desktop scanner to act as a low cost, portable, precise, and accurate sensor. The scanner favorably competes with sophisticated spectrophotometers in the assessment of silver and gold in a range of complex environmental samples using a novel rhodanine derivative in the presence of cationic surfactants.

Summary

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Herein, a desktop scanner followed by digital image-based analysis (DIBA), was used as a favorable competitor to sophisticated spectrophotometers for the assessment of silver and gold in complex real samples. The current work used a specifically tailored Syringalrhodanine (SR) as a novel chromogenic reagent in the presence of cationic surfactants.

Distinctively, our method has been thoroughly investigated, optimized, validated and successfully applied to complex samples, using the desktop scanner following respective recommended procedures. Images of Ag-SR and Au-SR colored complexes were captured, cropped and analyzed based on the standard RGB color mode to give RGB intensities that were converted to the corresponding color absorbance values. The plot of silver or gold concentration versus color absorbance, derived from digital images, gave linear relationships, limit of detections and limits of quantifications that favorably compete with the corresponding data obtained with sophisticated UV-VIS or ICP-AE spectrometers.

Maximum enhancement of the absorbance of the Ag-SR chelate was obtained in the presence of cetylpyridinium chloride (CPC). The metal ion forms two ternary complexes depending on SR concentration. The stoichiometries of the complexes are 1: 1: 1 and 1: 2: 3 (Ag-SR-CPC). The complex with the higher reagent-to-metal ratio was used for the determination of the metal. In the pH range 9.6-10.2, the molar absorptivity is 3.63×10^4 L mol^{-1} cm^{-1} at 550 nm. The method adheres to Beer's law for 0.15-2.5 µg mL^{-1} of silver and the corresponding sensitivity is 0.0029 µg cm^{-2} for both the spectrophotometric and the scanner results.

In case of the Au-SR chelate, maximum enhancement of the absorbance was obtained in the presence of Cetyltrimethylammonium chloride (CTAC). The metal ion forms two ternary complexes depending on SR concentration. The stoichiometries of the complexes are 1: 2: 3 and 1: 3: 4 (Au-SR-CTAC). The complex with the higher reagent-to-metal ratio was used for the determination of the metal. In the pH range 9.6-10.4, the molar absorptivity is 6.15×10^4 L mol^{-1} cm^{-1} at 554 nm. The method adheres to Beer's law for 0.15-2.25 µg mL^{-1} of gold and the corresponding sensitivity is 0.0032 µg cm^{-2} for both the spectrophotometric and the scanner results.

The proposed methods for silver and gold were test by their application to the determination of silver in a silver-sulfadiazin cream and gold in electroplating wastewater samples, respectively. Moreover, we used the methods to determine silver and gold in geological samples containing both of them in addition to other precious metals. The obtained results were compared with the results obtained using ICP-AES. The statistical t-test and F-test at 95% confidence level clearly show that there are no significant differences between the means and variances of the methods.

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