

# Forensic Importance and Advancements in Microscopic Examination of Questioned Documents

V. Gupta<sup>1,2</sup>, H. Aniket<sup>1\*</sup>, Shivangi<sup>3</sup>, K. Saini<sup>1</sup>

<sup>1</sup>Department of Forensic Science  
Punjabi University  
Patiala, Punjab  
India

<sup>2</sup> Shimla Unit  
Central Forensic Science Laboratory  
Chandigarh  
India

<sup>3</sup>Department of Forensic Science  
Chandigarh Group of Colleges  
Jhanjheri, Mohali, Punjab  
India

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\* Contact information: Harsh Aniket, Department of Forensic Science, Punjabi University, Patiala 147002, Punjab, India; +91 8987492679; [harshaniket@gmail.com](mailto:harshaniket@gmail.com).

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**REFERENCE:** Gupta V, Aniket H, Shivangi, Saini K: Forensic importance and advancements in microscopic examination of questioned documents; *Forensic Sci Rev* 37:51; 2025.

**ABSTRACT:** Questioned document examination is one of the most challenging tasks in the field of forensic science. Examining the document without destroying its integrity is difficult in such cases. Microscopic examination is a noble and mostly non-destructive approach in document examination. It enables the examiner to visualize the evidence in the document, which would have been otherwise difficult with unaided eyes. The purpose of the study was to establish the importance of microscopic examination in document examination. A critical review of 60 years, from 1963 to 2023, of various research papers from different journals has been conducted. Applications of various microscopes including stereo microscopes, digital microscopes, scanning electron microscopes (SEM), and atomic force microscopes (AFM) were reviewed. Compared to the basic examinations performed before the year 2000, there was a remarkable evolution involving complex examinations with more precise results after the year 2000. Microscopy helped solve almost all kinds of problems involved in document examination. Among all microscopes, the stereo microscope was found to be a prominent tool in document laboratories. Certain limitations were also listed for microscopic examination over spectroscopic methods. However, microscopes have been the tool of choice for forensic document examiners.

**KEYWORDS:** Atomic force microscope, comparison microscope, digital microscope, forensic microscopy, scanning electron microscope, stereo microscope.

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## INTRODUCTION

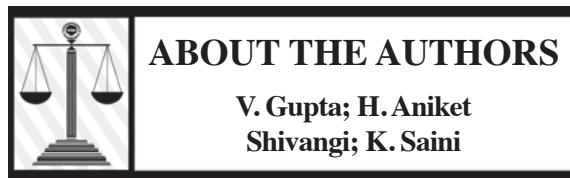
The wonders of the microscopic world can be discovered using a basic microscope. Equipped with an objective lens and an eyepiece, this essential tool allows users to observe and analyze a variety of specimens in greater detail. Using microscopes greatly enhances one's ability to examine and analyze questioned documents for evidence that may not be easily visible to the naked eye. Thus, microscopy has become an indispensable tool in modern forensic science. Among the numerous applications of microscopy in various disciplines of forensic science, it has proved to be the most important tool in forensic questioned document examination. Advancements in technology have led to the inclusion of other elements for more precise sample examination. Implementing different types of microscopic techniques has greatly empowered forensic document examiners, enabling them to provide conclusive opinions in various criminal investigations [14]. Thus, microscopy provides indispensable and clear facts that can help in the administration of justice in the court of law [57]. Prosecution attorneys often use the results of microscopic examination. However, these can be used as an advantage by defense lawyers as well [60].

Magnification is crucial in examining documents. It can be achieved through photography, videography,

or microscopy, but optical microscopes are preferred for accurate analysis [17]. Microscopic examination is the most reliable and non-destructive approach for document analysis in almost all cases. The accuracy of this method is unparalleled, and it ensures that the documents remain intact with certainty of the most precise results possible. The experienced eye can identify numerous pieces of evidence under a microscope without altering the document or causing much harm. Fraudulent alterations, documents involving forged handwriting, the chronological sequence of strokes, typewritten materials, etc., can be examined under a microscope [57]. A range of microscopes are confidently employed in the examination of questioned documents. These microscopes function differently and are used in a variety of cases. A succinct overview of the microscopes employed to examine questioned documents is summarized.

A **stereo microscope** is an optical device that has one objective lens and two eyepieces to provide binocular vision. It has comparatively lower magnification, a large field of view, and a greater depth of field [91]. No sample preparation is required because of the low magnification with reflected light. Various aspects of forensic document examination were studied and established using stereo microscopes [1, 11, 13, 19, 22, 24, 37, 49, 50, 56, 62, 64–66, 75, 76, 80, 81, 83, 89, 90, 93–95].

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**Vinayak Gupta** was born and raised in Shimla, Himachal Pradesh, India, and developed a passion for criminal investigation at a young age. This early fascination led him to pursue higher education, earning a forensic science degree specializing in questioned document examination and fingerprint analysis from the Department of Forensic Science, Punjabi University (Patiala, Punjab, India). He is currently employed as a forensic professional at Central Forensic Science Laboratory Unit Shimla (Shimla, Himachal Pradesh, India), formerly the Office of the Government Examiner of Questioned Documents (GEQD). Alongside his work, he has submitted his Ph.D. thesis in the field of questioned document examination in the Department of Forensic Science, Punjabi University.

Vinayak has achieved great success through his unwavering dedication and hard work, earning a gold medal at the master's level. Throughout his career, he has demonstrated a commitment to the field and contributed valuable insights by publishing seven research papers in national and international journals. He has participated in 11 national and international conferences/seminars and consecutively won best oral/poster presentation thrice.

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**Harsh Aniket** was born and brought up in Ranchi, Jharkhand, India, then moved to Patiala, Punjab, India, where he pursued his master's in forensic science, specializing in questioned documents and fingerprint examination from the Department of Forensic Science, Punjabi University. He is currently pursuing his Ph.D. from the same department and also gives lectures in the department on questioned document examination, fingerprint examination, and forensic ballistics.

Harsh has interned in the ballistics division at the State Forensic Science Laboratory (Ranchi, Jharkhand, India). He has hands-on experience handling various instruments such as ATR-FTIR spectrometers, stereo microscopes, and comparison microscopes. As the beginning of his research journey, he has enthusiastically participated and contributed to multiple research projects that are currently being reviewed for publication. He has presented his research papers at three national conferences based on forensic science and has won awards for them. Harsh anticipates working on more scientific initiatives in the future.

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**Shivangi** is based in Patiala, Punjab, India and holds a postgraduate degree in forensic science from the Department of Forensic Science at Punjabi University. She is an assistant professor of forensic science at the Chandigarh Group of Colleges (Jhanjheri, Mohali, India).

Shivangi's specialization lies in questioned documents and fingerprint examination. Prior to her current position, she served as an assistant professor at Dolphin PG College of Sciences (Fatehgarh Sahib, Punjab, India). She has also interned at the State Forensic Science Laboratory in Mohali (Mohali, Punjab, India). Shivangi has participated in three national seminars and conferences.

**Komal Saini** is originally from Patiala, Punjab, India, where she also finished her prior education. She was awarded a Ph.D. in 1997 on the topic “A Study of Various Factors Influencing Handwriting”. Currently, Dr. Saini is a professor in the Department of Forensic Science, Punjabi University and has 21 years of teaching experience in questioned document examination and forensic ballistics.

Prof. Saini has supervised 10 Ph.D. research scholars and about 43 M.Sc. dissertations on various topics. Prof. Saini has 44 research papers published in prestigious national and international journals and publishing houses, in addition to two books and one book chapter. She has attended 23 national and international conferences/seminars/symposia and presented myriad plenary/invited lectures. A Department of Science and Technology project under Women Scientist Scheme was taken by her in 2005 entitled “Forensic Identification and Detection of Fraudulent Photocopies”.

In recent years (2016–2019), Prof. Saini has served as the head of the department, chairperson of the Admission Committee, Board of Studies, Research Board, and Academic Council of the Department of Forensic Science. She is a member of three professional organizations, namely the Indian Academy of Forensic Science, the Indian Science Congress Association, and the Punjab Academy of Science. She is also a member of the board of studies in the Department of Criminology and Forensic Science, Dr. Harisingh Gaur Vishwavidyalaya (Sagar, Madhya Pradesh, India) and Aditya Degree College (Surampalem, Andhra Pradesh, India).

