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USE OF THE ATOMIC FORCE MICROSCOPE IN THE FORENSIC DETERMINATION OF CHRONOLOGICAL ORDER
OF TONER AND BALLPOINT PEN INK IN QUESTIONED DOCUMENTS

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The most complicated type of forgery documents is considered. The article focuses on the atomic force microscope as the best method to determine the chronological order of crossing traces in questioned documents. The undeniable advantages of the method are shown and illustrated.

Introduction. There is a widespread method of signing the original document, at a business meeting, for example, then printing an additional paragraph on the blank paper space. This type of forgery documents are the most complicated to appraise them forensically.

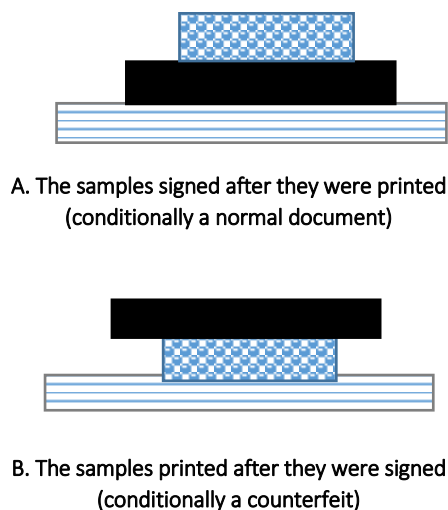


Figure 1. – Schemes

Almost all expertise is carried out by experts of the State Forensic Committee of the Republic of Belarus. They are equipped with optical microscopes to examine the overlapping of printer toner and ballpoint pen ink to determine the chronological order of the printing. This method has its limitations and doesn't allow to achieve results in some cases.

The Atomic Force Microscope (AFM) principle. The AFM is a device that is designed to use the force of elements between the cantilever-end probe and the surface of the sample and measure the shape of the surface [1]. AFM analysis can measure not only the morphology of the surface of samples, but also the surface roughness, lateral force, phase imaging, hardness, and adhesion [2]. AFM also implements 3-d images, which you could see on Fig.2.

Preparation of the samples. 10 samples were prepared by printing out ten sheets of A4 size paper and signing them. Other 10 were prepared by printing out ten sheets of A4 size paper and signing them, then printing one more paragraph on the each of them. The first group of samples was named as "Conditionally normal documents" and marked with the letter "A". The second one was named as "Conditionally counterfeit documents" and marked with the letter "B". Each of them was examined on AFM.

Results. The difference between the first sample of the "Conditionally normal documents" group and the first sample of the "Conditionally counterfeit documents" group are shown.

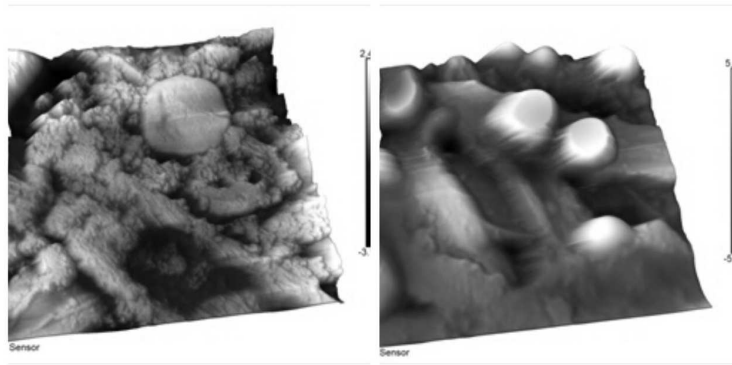


Figure 2. – 3-d images produced by AFM: the sample signed after it was printed (left one – A) and the sample printed after it was signed (right one – B)

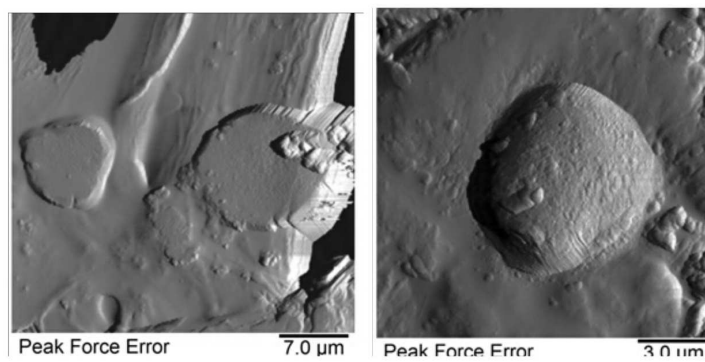


Figure 3. – 2-d images produced by AFM: the sample signed after it was printed (left one – A) and the sample printed after it was signed (right one – B)

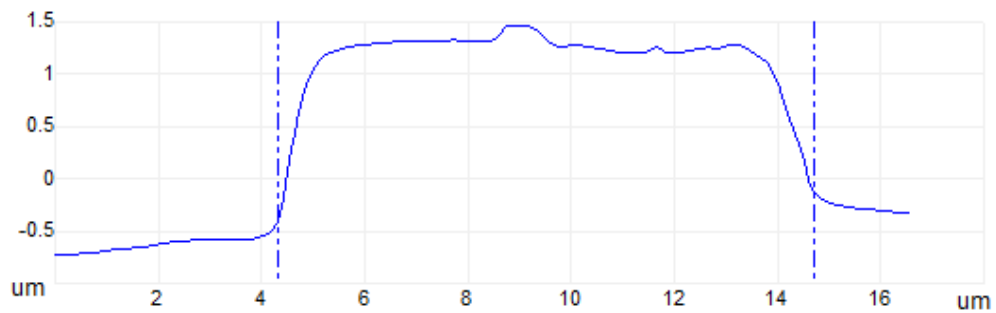


Figure 4. – Surface topography of the sample signed after it was printed (A).
Height 1,913 μm. Width 10,435 μm

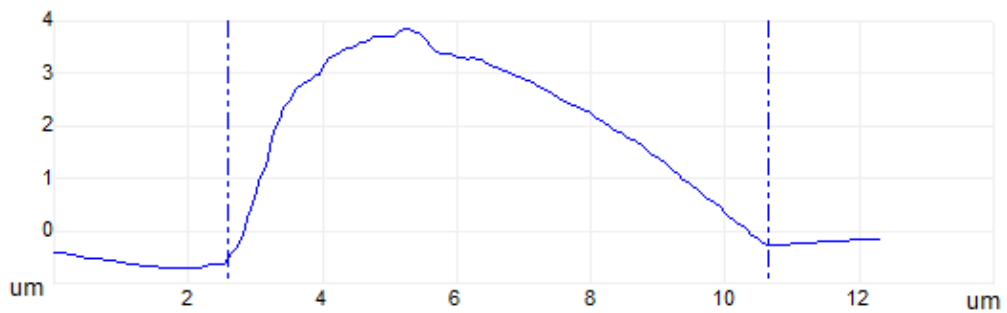


Figure 5. – Surface topography of the sample printed after it was signed (B).
Height 4,306 μm. Width 7,978 μm

The images of adhesion are also differing. The same is about adhesion profiles.

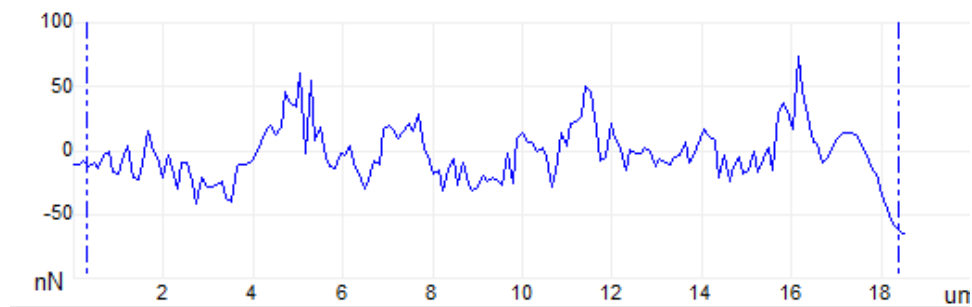


Figure 6. – Adhesion profile of the sample signed after it was printed (A)

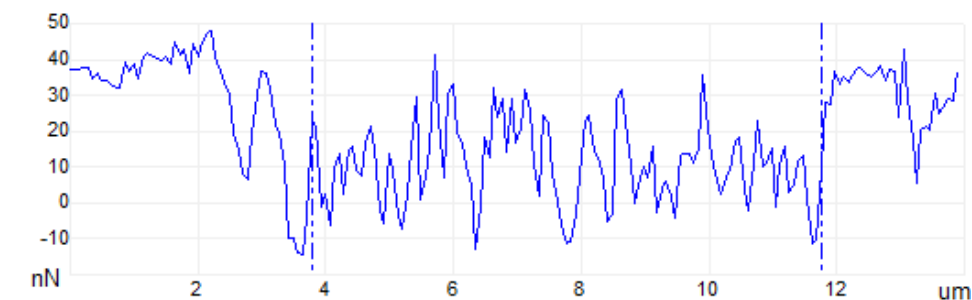


Figure 7. – Adhesion profile the sample printed after it was signed (B)

Conclusions. This study presents a new method of analyzing of crossing traces in questioned documents. Use of AFM could make even the most completed cases in forensic practice solvable. The major and the only one disadvantage of the method is its high cost.

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