Analysis of Ancient Paper Structure in Transmitted Light by Application of Different Microscopic Techniques. Examples From Collection of The Kórnik Library of the Polish Academy of Science (*)

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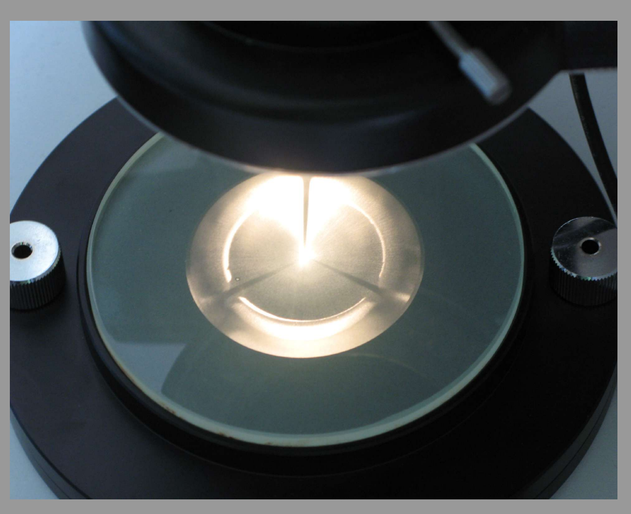
The Kórnik Library was established in 1826, when the first permanent photography was taken. The abundant photographic collection is composed of photographs taken in different techniques (mainly on paper, but also on glass, fabric and metals), and come from Polish as well as many world ateliers (many European countries, Australia, the US, the Middle East and other regions). These photographs were taken by many photographers, and the collection contains many famous surnames like for example Fox Talbot, Walery Rzewuski, Karol Beyer.
In general, handmade or machine made paper is a product which shows a certain transparency. However, some kinds of paper found in museum, library and archive collections may reveal a more noticeable transparency (tracing papers, waxed paper negatives etc.). The degree of transparency of paper products depends on their thickness, technology production, pulp composition, additional substances applied and other agents. In this field stereoscopic microscopes with additional equipment offer many possibilities in non-invasive investigations of paper surface structure, as well as its look-through by scientists and conservators. Additional helpful tools are the equipment for polarization (the polarizer, the analyzer) and the dark field condenser easily mounted in the stereoscopic microscopes. They are very useful tools for obtaining much more information on antique paper structure without any sampling in comparison with the results obtained by normal light applications. They are one of the cheapest tools that conservators may buy, and their use is very simple. Beside fibers which the paper is composed from, it is possible to determine the presence of many additional inorganic and organic matters in the paper structure. Of course, not only paper photographic materials are present within collection of photographic materials. There are glass plate negatives as well as negatives on artificial supports. Additional materials such as enclosures and other associated ones can be examined by conservators. The indicated examples of the polarized light and dark light application are only examples.

The polarized light application

First of all, it is a very helpful tool for application to the photographic glass and on artificial support negatives because of their best transparency within photographic materials. Glass degradation products and mechanical damages, emulsions decays can be studied successfully. Microorganisms, crystals, dirt, protective varnishes on emulsions, retouches and other substances become much more legible in this light. Only thin papers or fragments (obtained by sampling) as well as paper bits (as the results of paper decay) may by studied by this technique. For thick papers the polarized light is not sufficient. In polarized light the presence of fillers can be detected and it is also possible to analyze their distribution within the paper (in wrapping papers for photographic storage purposes), crack lines of overlayers, writing or painting inks distribution, photographic images (obtained mainly from silver particles) on paper surfaces, as well as distribution of substances applied by conservators (cellulose derivatives, powdered erasers used for cleaning etc.). It is only one the most important limitation – analysed paper must be thick or even better – transparent such as the tracing paper. In some cases it is possible to identify the types of fibers by analysing their morphological features and colours appearing during polarization. The paper marges and areas within tears or holes are the best places for identification, because the fibers protrude. But the minimal magnification ca. 100-120 times is needed (optimal is 150-200, and sometimes even more). Performing identifications within non damaged areas may be impossible because of the compacted structure of the paper fibers. Of course an exception may occur. But the presence of dyed fibers (wool, flax etc.) and fiber bundles (hemp or poor processed flax) are easily to distinguish from white or yellow paper pulp. When paper is sampling to obtain a microsample intended for the fiber identification we may obtain not quite enough needed information. Noninvasive investigations such as the polarized light or the dark light technique fills in the required information on its morphology. It is necessary to emphasize another possibility of the technique. When paper structure is observed in the transmitted light next to edges the problem of camera settings may appear because of the occurrence of an intensive contrast between an intensive light and a dark sample put on a microscope glass. The polarizing light solves this problem – the paper structure is well visible whereas the surrounded background is of dark grey-blue colour. Similar helpful effect occurs in the black light technique. Artificial support of negatives such as nitrocellulose and later discovered cellulose derivatives applied in photography can be also observed in the polarized light.



The dark field application

The dark field technique is suitable mainly for investigations on glass negatives or on artificial supports. Thin or transparent papers are the best among paper products used in the previous technique. For thick paper or other compacted structures this technique is not sufficient.
By using the dark field condenser it is possible to observe light paper structure (from white to grey) on a dark background. The image is reversed (like a negative) in comparison with an image obtained in normal transmitted light, where the dark outline of fibers are visible in the light field. The stronger contrast is also characteristic for the dark field technique. Therefore, the technique may be applied for studying of a thin structure of different materials, anatomy of damages and degradation products. The best results are visible on single fibers or their thin network, fully or of high transparency materials. Helpful may be a technique of simultaneous use of the black field and reflected light (low angle of reflection: ca. 10-20^{o})which serves to provide an additional interesting effect of a mixed image where the paper is observed in a dark field but at the same time the structure of the surface is also visible. But also it is possible to apply the dark light not to observe paper structure. The thick and quite not transparent photographs on paper support such as silver-gelatin or collodion alone on a backboard can be observed on the black light background with simultaneous application of a reflected side light (low angle). One of the most important factor in photographs identification is the presence of the so called baryta layer. The white layer is better identifiable by application of the mentioned technique than in a normal reflected light. There is a phenomenon of our perception. The presence of a black background creates a bigger contrast as well as eliminates additional stimulus by which there is better absence of our concentration. Both polarized light and dark light techniques are sufficient to apply in microscopes localized in a dark laboratory or with special protective covers to cut daylight or artificial light access. A near presence of windows reduce and worsen investigation results. Not always the techniques are effective. It depends on our requirements, and like every method they have limitations.

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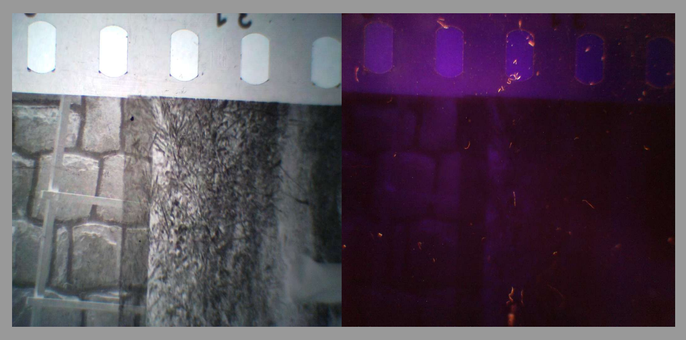
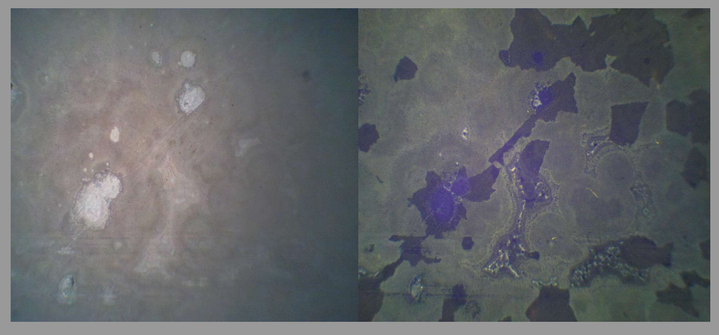
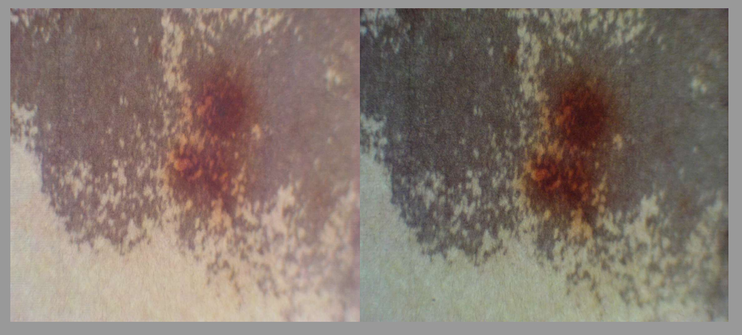


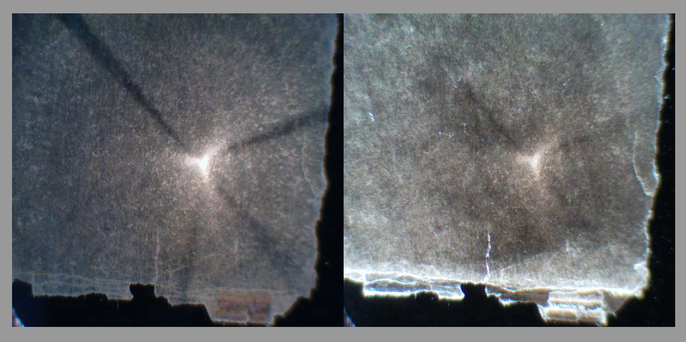
Synthetic negative - normal (left)
and polarized light (right)



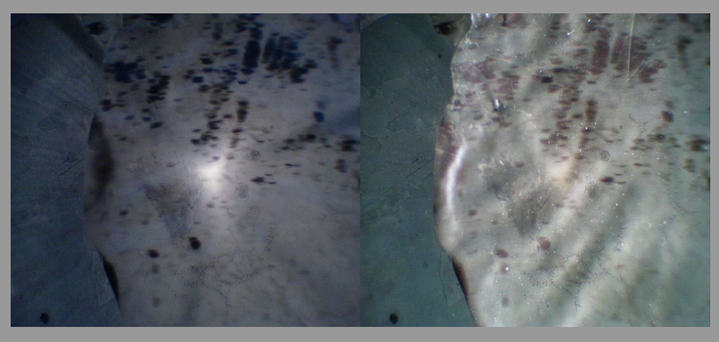
Surface decay of glass negative -
normal (left) and polarized light (right)



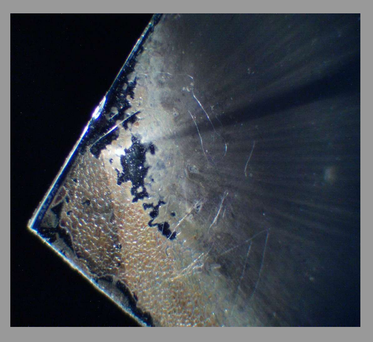
Foxed albumen print - normal (left)
and polarized light (right)



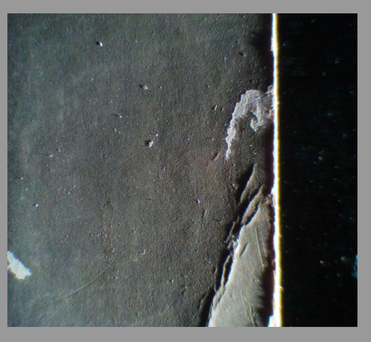
Tracing paper – dark field (left)
and dark field + reflected side light (right)



Photographic glass negative with silver-gelatin emulsion - dark field (left) and dark field + reflected side light (right)



Photographic glass negative with silver-gelatin emulsion
- dark field



Silver-gelatin print on paper
- dark field + reflected side light