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**Characterizing United Press International's Unifax Facsimile Prints**

## **Abstract**

This paper explores an outmoded facsimile printing technology employed in wire transfer facsimile machines in the mid-twentieth century. Major news agencies such as the Associated Press and United Press International provided wire-transfer facsimile services to share news images with their subscribers. Facsimile printing machines accelerated the transmission of images, subsequently printing them using a variety of techniques including traditional gelatin silver printing, and electrostatic and thermal processes. This paper describes a technique called electrolytic printing, which has been largely left out of the dominant literature on facsimile technology. Electrolytic printing was popular in news agency machines from the mid-1950s to approximately the mid-1970s. Prints from this process have distinct features including a warm image tone, limited detail in the high-density areas, partially translucent paper supports, and the image is almost as clear on the verso as it is on the recto. The image materials are investigated, as well as preservation concerns.

## **Introduction**

In 2006 the Tamiment Library & Robert F. Wagner Labor Archives at New York University (NYU) acquired the archive of the Communist Party of the USA (CPUSA). The collection contains the photograph morgue of the CPUSA's newspaper, the *Daily Worker*, which comprises 224 linear feet of press images made in various photographic processes. As part of the cataloging protocol NYU staff archivist Hillel Arnold and Conservation Librarian Laura McCann worked to identify the processes and news sources. They identified gelatin silver developed-out prints and chromogenic prints made by the *Daily Worker*'s staff photographers, as well as electrostatic and thermal facsimile prints made on wire transfer facsimile printing machines from both the Associated Press (AP) and United Press International (UPI). One type of print found in the collection was distinctly different from all the others and Mr. Arnold and Ms. McCann identified the source as UPI's facsimile printer, the Unifax. Research into the Unifax revealed it was inaugurated February 27, 1954 (*Editor & Publisher* March 6, 1954, page 12). However, further investigation revealed that no literature exists to describe how the printer worked, or what composes the image material. Given the absence of information and concerns regarding the long-term stability of Unifax prints, the project was passed on to the author with the following goals: research the history and development of wire transfer facsimile printing and create a timeline for the development and use of the Unifax printer; determine the materials and methods of production of Unifax prints; and conduct preliminary research into the stability and preservation of Unifax prints.

## **History of Wire Transfer Facsimile Printing and Unifax**

The invention of wire transfer facsimile printing is intertwined with technological developments of the Industrial Revolution, and it played a significant role in the globalization of information through the nineteenth and twentieth centuries. The timeline begins following Samuel Morse's 1837 invention of the telegraph, a method for coding and sending messages as electrical current. Shortly after a man named Alexander Bain invented the earliest concept of a facsimile printer, which he received a patent for in 1843 (Costigan 1978, 2). Bain developed the idea for this printer from his prior invention of a

synchronized clock system. He determined that if synchronization could be maintained between a master and a system of machines, then the same could apply for replicating text and images. For his facsimile printer Bain designed a metal stylus that simultaneously traced the original text (which needed to be in relief) and contacted a piece of paper saturated with water, sulfuric acid, and a saturated solution of yellow prussiate of potash (Costigan 1978, 3). The electrical reaction between the metal stylus and the wet components created the dark areas of the image. Bain's system was not economically viable for its time, but it did incite continued research including Giovanni Caselli's "pantelegraph", which received a patent in 1861. Caselli oversaw the construction of telegraph lines specifically for his instrument throughout France and Europe in the 1870s, which transmitted hand-written notes and simple line drawings (Huurdeeman 2003, 49).

Dr. Arthur Korn is another important inventor credited with setting up a dedicated transmission system between Berlin and London in 1910, and for sending the first transatlantic image via radio wave from Rome to Bar Harbor, Maine, in 1922 (Costigan 1978, 4). The transmission stirred American interest in this technology, leading three companies to establish their own dedicated systems: the American Telephone and Telegraph company (AT&T), the Radio Corporation of America (RCA), and Western Union. In 1934 the AP bought out AT&T's picture division, and then dramatically unveiled a nation-wide system at one o'clock in the morning on January 1<sup>st</sup>, 1935 (20 Years with AP Wirephoto, 1). The AP's innovative network of telephone wires connected newspapers in twenty-one cities across the country to a central hub in New York. There, a machine would scan a photographic print and convert the density information to electrical signal. The signal would then travel over the telephone lines to distant cities where receiving machines would reconvert the signal into density information and transfer it to photographic negatives. This meant the receiving newspaper had to subsequently print the negative into a positive silver image, which had many drawbacks including limiting the speed at which a newspaper could turn around an image for printing.

Nearing the middle of the twentieth century new non-silver printing technologies began to be introduced into facsimile printing systems. Interestingly, the AP and UPI almost simultaneously introduced similar non-silver systems in 1954. UPI received a trademark for the Unifax in June of 1954, and the AP received a trademark for their version, Photofax, the following August (United Press Associations Corporations, trademark 71668129; Associated Press Corporation, trademark 71671083). Curiously, no patents exist for the Unifax or Photofax machines. These two machines employed the same technology, which appears to have used materials similar to Alexander Bain's original concept (Diamond and Carr 1972, US patent #3,668,079). The technology is referred to as "electrolytic facsimile printing" and it relies on a chemical reaction facilitated by an electrical current in the presence of an electrolyte solution. Unlike the later techniques of electrostatic and thermal facsimile printing, electrolytic printing was entirely abandoned as a facsimile technique. Very little literature or research exists describing this process, despite its otherwise wide and popular use in the middle of the twentieth century.

### Technical Description of the Process

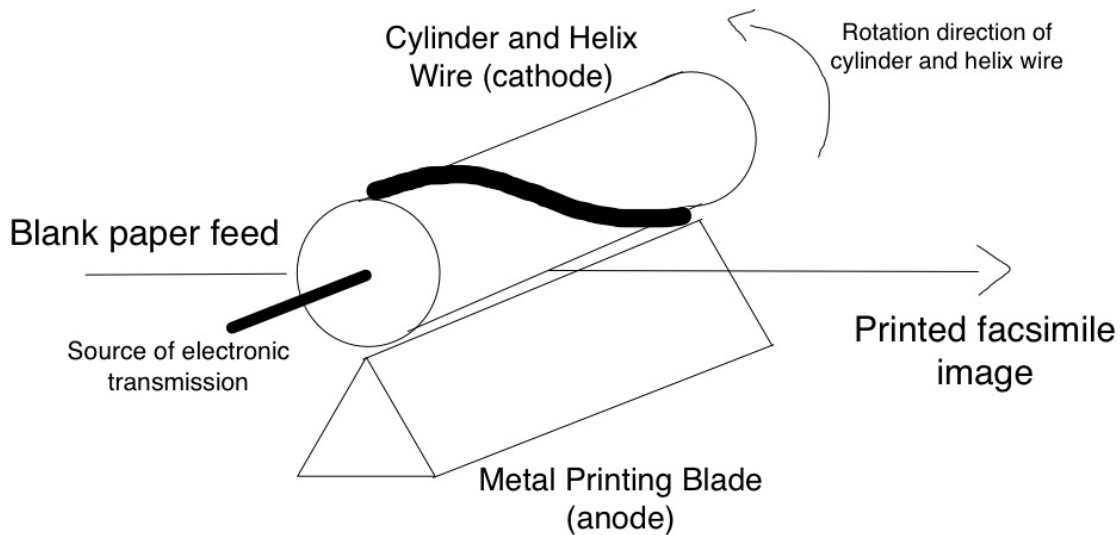
Unifax prints, and electrolytic facsimile prints in general, have many unusual characteristics. An image created by the Unifax machine is printed on a partially translucent paper support, and is monochromatic in a range of warm brown densities. The paper support retains good flexibility and feels satiny to the touch. There is no baryta or similar ground layer, nor is there evidence of a binder such as gelatin. The image is made up of many parallel lines, barely visible to the naked eye. Detail is often lost in the high-density image areas, resulting in regions of flat, dark color. Perhaps one of the best identifying properties of electrolytic prints is that the image is almost as clear on the verso as it is on the recto. Frequently the edges of the prints are unevenly trimmed, although two opposite edges will always be machine-cut. This is a result of the paper being fed from a roll. Finally, there will always be a strip of printed text as part of the image identifying the subject and the news source.

During cataloging of the *Daily Worker* collection archivists noticed the Unifax prints had a tendency to offset ghost images onto each other, and they appeared to have stained their original, poor-quality folders. These observations raised concerns regarding their preservation, which have yet to be resolved. The Unifax prints were rehoused at Tamiment Library in good-quality folders, separated from the other photographic materials as a precaution against further offsetting. After approximately two years the prints do not appear to have caused any changes to their new folders or to each other.

While no patent is available for the Unifax printer specifically, many patents can be found for various electrolytic facsimile printers and printing papers. It seems likely that UPI and the AP were re-branding printers made by other companies and simply providing a non-stop stream of images. U.S. patent #3,668,079, filed by Arthur S. Diamond and David E. Carr in 1971, is the only patent to reference the Unifax printer (and the AP Photofax printer), and it has provided the basis for the following description of the printing process. Electrolytic facsimile printing works on the same principle as an electrolytic cell, whereby a flow of electrons is established from an exterior energy source between a metallic anode and cathode in the presence of an electrically conductive solution. The result of such a cell is the depletion of metal at the anode and plating out of metal at the cathode. In the electrolytic facsimile printing machine there is a cylinder with a metal wire wrapped around it (called a helix wire), which acts as a cathode and rotates during printing. Positioned below the cylinder is a stationary metal blade, commonly made from iron, steel, copper, or silver, which acts as an eroding anode. Paper is fed from a roll between these two parts and receives the facsimile image. A single rotation of the cylinder causes the helix wire to mark a single line across the printing surface. The image is then built up from many printed lines in succession.

The physical creation of color on the facsimile paper is a result of the reaction of metal ions from the anode with chemicals in the paper. A manufacturer supplied the blank facsimile recording paper impregnated with an electrolyte solution and a special "marking compound". Information regarding the "marking compound" is limited and appears to be proprietary, although most sources agree it is a polyphenolic compound, and was often catechol. The electrolyte solution contains an ionizable electrolytic salt, such as sodium chlorate (Diamond and Carr, 1971). During printing the helix wire in the mechanism receives the electrical signal from the wire transmission and a current is established between the anode and cathode, maintained by the electrolyte solution in the

paper. The current causes the eroding metal blade to deposit metal ions into the blank facsimile paper. The metal ions then react with the “marking compound” to form the image (see Figure 1). The signal strength varies in accordance with the image densities of the picture being transmitted, so a stronger signal corresponds to a high-density area and a weaker signal corresponds to a lower-density area. When the signal is strong more metal erodes and a darker color is formed on the facsimile paper. Conversely, when the signal is weak only a small amount of metal erodes from the anode and a lighter color is formed.



**Figure 1:** *Illustration of the basic mechanism of the electrolytic facsimile printer. Paper is fed from the left side between the helix wire and the printing blade. The electrical signal received from the transmission establishes a current between the helix wire and the printing blade. Metal ions then erode from the blade into the paper and react with the polyphenolic marking compound to create color.*

As an aside, it is important to note there appear to be two types of “electrolytic printing”. There is the type described above, which share similar features with the original invention of Alexander Bain, and there is another version that can be found in several texts regarding facsimile technology (Batterham 2008, Nadeau 1989). This second technique is described as a paper covered with a thin metal foil, coated with zinc oxide. Electrical charge is applied to the paper in order to produce a facsimile image. It appears the main application for this version was the positive reproduction of microfilm. No text has been discovered yet to explain why these two techniques share a common name, but for the purposes of this research the second version will not be regarded.

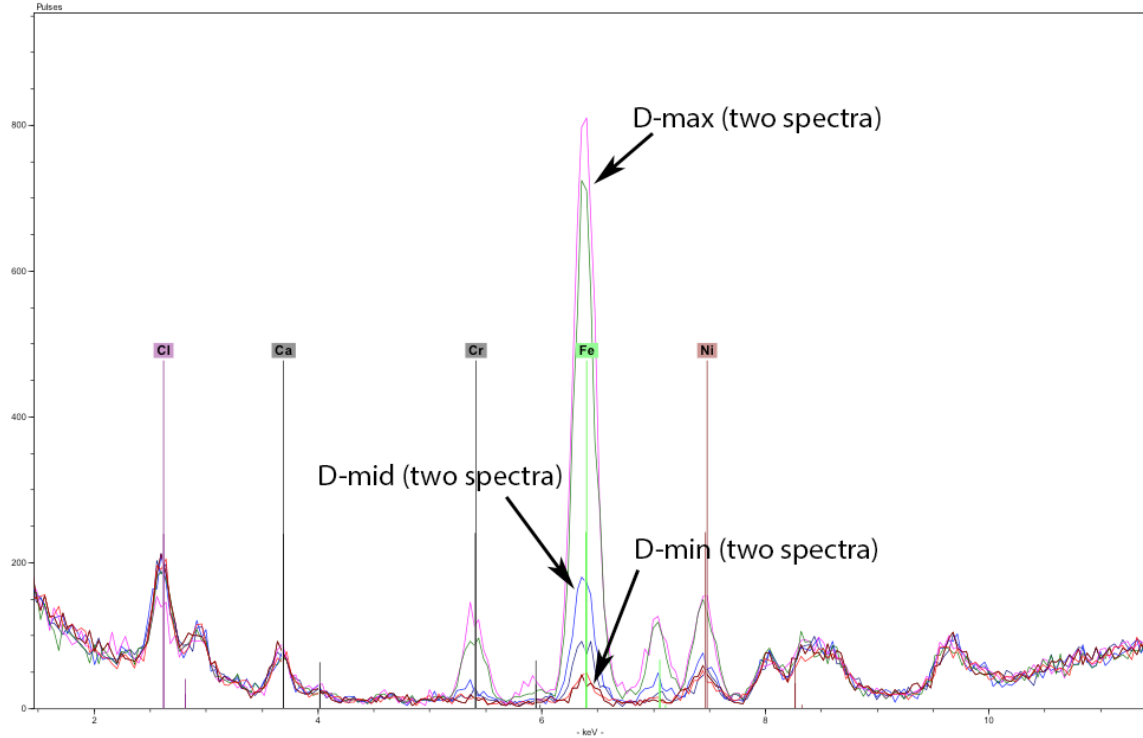
### Material Investigation

Published descriptions of the electrolytic process shed light on the mechanical operation of the facsimile machines, however they do not explore the chemical makeup of the image material. Three prints from the *Daily Worker* archive were deaccessioned for analysis to be used as representative examples of the Unifax process. The goal of the analysis was to determine more precisely the chemical composition of the image material

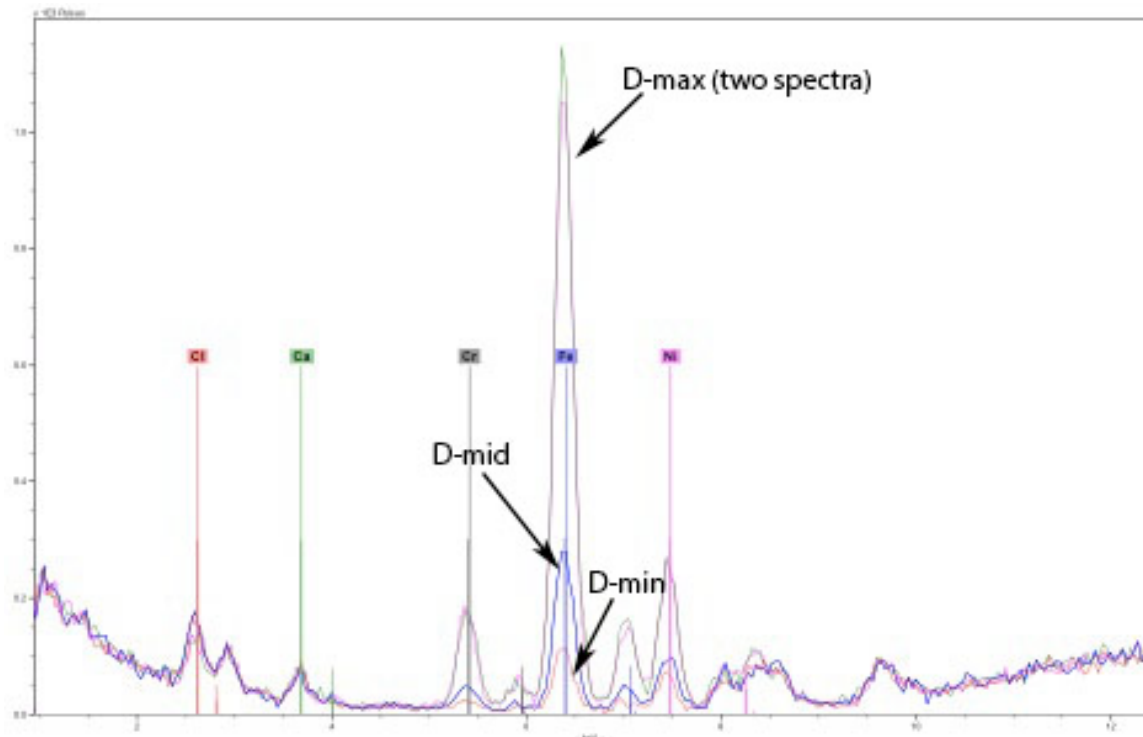
and the paper support. Information culled from a 1948 research paper on high-speed electrolytic facsimile printing explains there are four types of chemical reactions that may occur in any order during electrolytic printing. The first reaction is caused by general introduction of foreign ions into the paper blank, the second by discharge of ions at an electrode while in contact with the blank, the third by oxidation or reduction at the electrode when in contact with the blank, and the fourth reaction occurs through increasing the concentration of an ion at the contact point to induce a pH change (Greig 1948). One or several of these reactions may occur during printing, however the initiating reaction distinguishes the processes and may depend on the particular chemicals present during printing. Based on subsequent descriptions of the reactions it appears the Unifax method can be classified as an introduction of foreign ions into the paper blank. In the process foreign ions react with the organic solution impregnated in the blank to form metal-organic chelate compounds, precipitated metal, or colored inorganic metal derivatives (Greig 1948). The analysis subsequently described here aimed at confirming this information with the resources and equipment available to the author.

Beginning with non-invasive tests, the Unifax prints were observed under short wave ultraviolet radiation. The image areas did not exhibit any significant fluorescence, however portions of the unprinted paper fluoresced a bright white. These portions correspond to areas that look like dried water spots when viewed under normal lighting conditions.

The next technique employed on the Unifax sample prints was X-ray fluorescence spectroscopy with a Bruker Handheld Tracer III-V, using an air-backed set-up. Tests were run for 120 seconds at 40 kV and 1.5 $\mu$ a without a filter. The spectra revealed significant peaks for iron in the high-density areas of the image, which became proportionally shorter in the medium-density areas and almost negligible in the non-image areas (See Figures 2 and 3). Other significant peaks corresponded to chlorine, calcium, chromium, and nickel. The intensity of the calcium and chlorine peaks did not vary in relation to the image area, thus these elements are likely a component of the paper or relate to the electrically conductive solution. However, the intensity of the chromium and the nickel peaks corresponded by ratio to the intensity of the iron peak, so they are likely components involved in the image making process resulting in an iron-chromium-nickel image. Given the above description of how electrolytic printing works, it is likely these metals were present in the eroding anode printing blade. In addition, the combination of iron, nickel, and chromium is a formula for stainless steel, which is a documented metal alloy for printing blades.

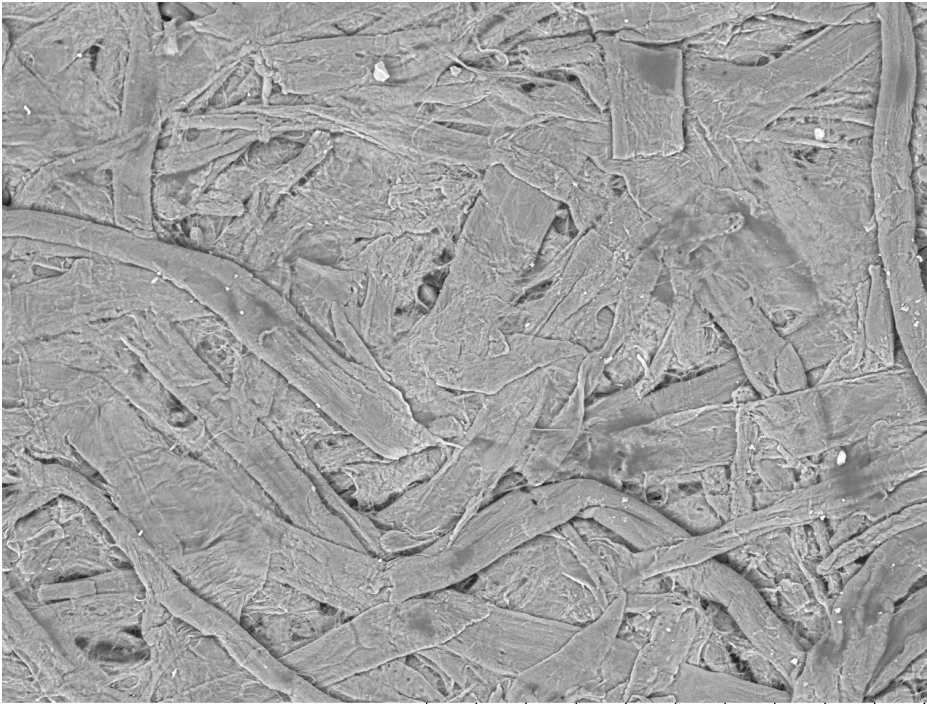


**Figure 2:** Sample print #1: showing chromium, iron, nickel peaks for the maximum-, mid-, and low-densities of the image.



**Figure 3:** Sample print #2: spectra for this sample as well as for sample #3 were virtually identical for the spectra for sample #1.

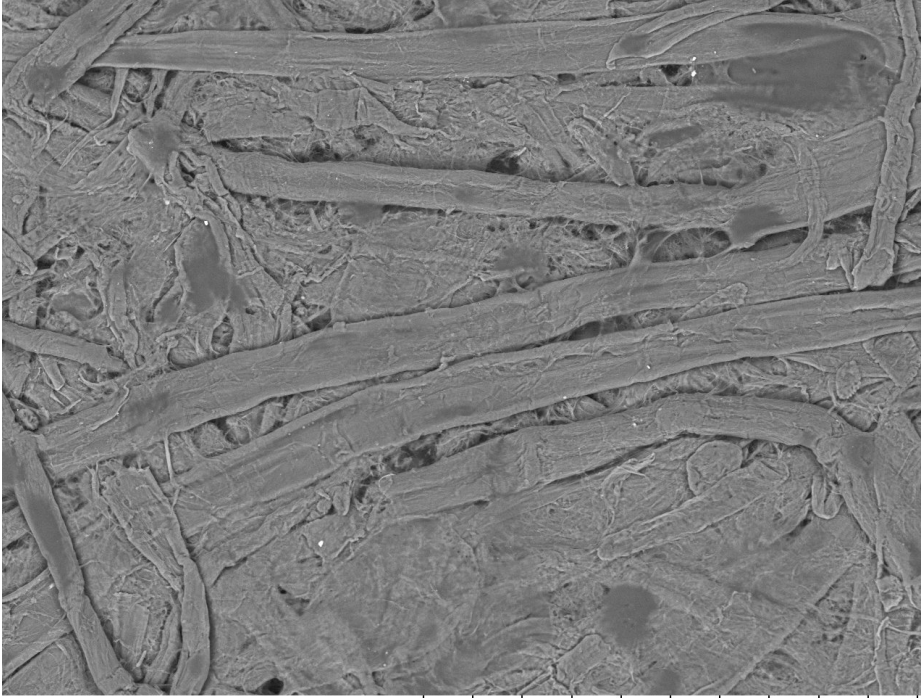
Scanning Electron Microscopy coupled with Electron Dispersive Spectroscopy (EDS) was performed with a Hitachi TM3000 desktop SEM connected to a Bruker Quantax EDS unit. High magnification images of the samples revealed only paper fibers; no image particles could be detected. SEM images of the high-density image areas showed no distinction from the low-density image areas (see Figure 4). Compositional analysis in high-density image areas was run at 15 kV and revealed average weight percent distributions of 49% oxygen, 44% carbon, 4% sodium, 1% chlorine, and less than 1% each of iron and sulfur. The composition remained roughly the same in the mid-density areas of image, with less than half a percent of iron. In the non-image areas no iron could be detected. The low content of iron found may be due in part to the detection limits of the instrument (operating at 15 kV). Unfortunately, this did not allow any mapping of iron on the surface of the sample to correlate iron content and image density. Since no specific local accumulations of iron were found, the EDS results suggest the iron from the eroding anode does not sit on the paper fibers as discrete particles, but is both finely dispersed and likely bound to molecules from the organic marking compound. This assessment describes a material that is similar in make-up to an ink or a dye.



TM-3000 0013

2011/11/15 14:42 HL D7.5 x300 300 um





TM-3000 0014 2011/11/15 14:52 HL D8.5 x300 300 um

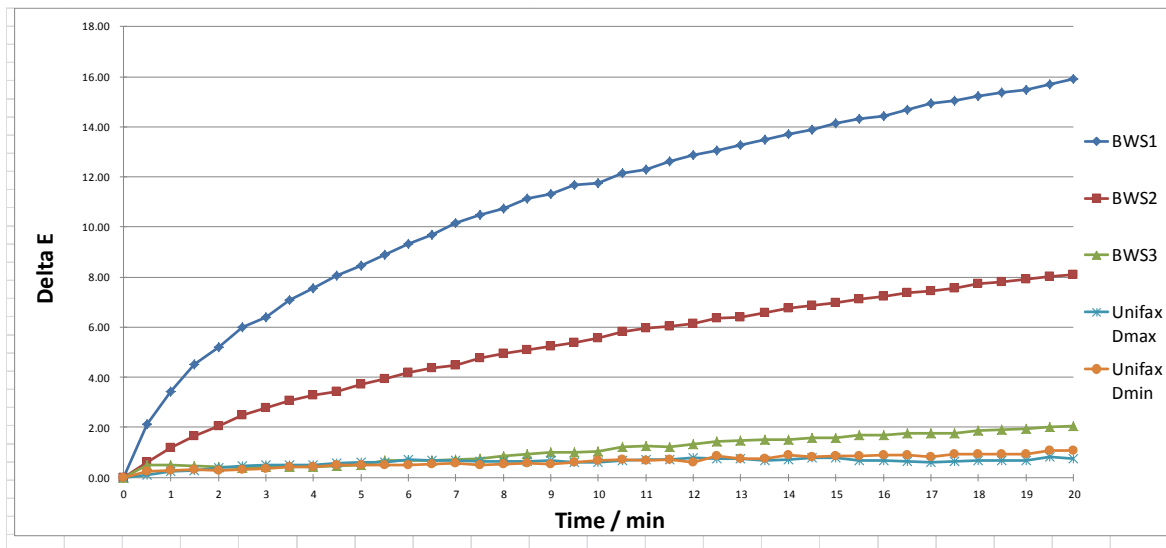
**Figure 4:** SEM microphotographs of two areas on the same sample: high-density image area (top) and low-density image area (bottom) reveal similar features: presence of paper fibers and absence of image particles.

Initial analysis with Fourier Transform Infrared Spectroscopy has not provided and conclusive information regarding the image material. Spectra taken in situ on the sample prints show bands typical for paper fibers, consistent with spectra for cellulose and natural fibers.

### Preservation Concerns

An important observation was made during FTIR analysis regarding the solubility of the image material. In an attempt to isolate the image material from the paper support small samples cut from high-density image areas on the sample prints were soaked in water. Almost immediately brown color from the samples began to dissolve into the water. Some color still remained in the paper after several days of immersion, suggesting that some, but not all, components of the image material are readily soluble in water. This discovery has important repercussions for the handling of electrolytic facsimile prints. It is important to protect these prints in collections from exposure to moisture and water, either from high ambient relative humidity, exposure to sprinkler systems, or in local treatments such as hinging and mending applications.

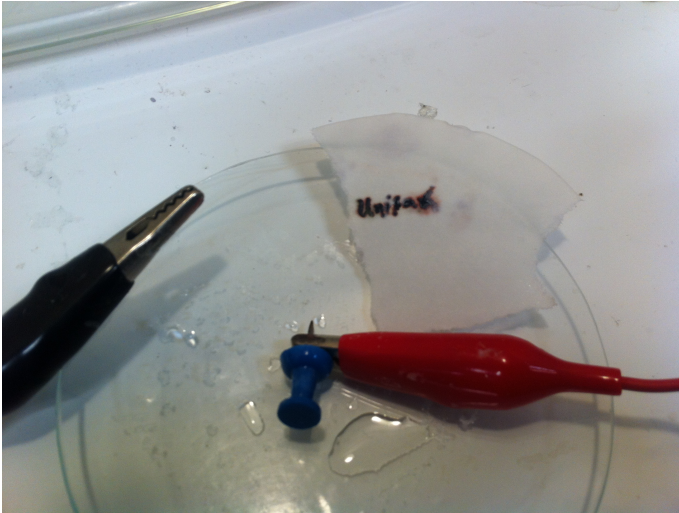
To address questions about the light stability of the image material, a sample print was tested with a Newport Oriel OMF-T microfading tester at The Metropolitan Museum of Art. Color change in maximum-, mid-, and low-density image areas were compared to Blue Wool standards 1, 2, and 3. All Unifax sites faded at slower rates than Blue Wool 3 (see Figure 5). These results suggest that the prints are less sensitive to light than the most light-sensitive Blue Wool standards (Whitmore, 1999).



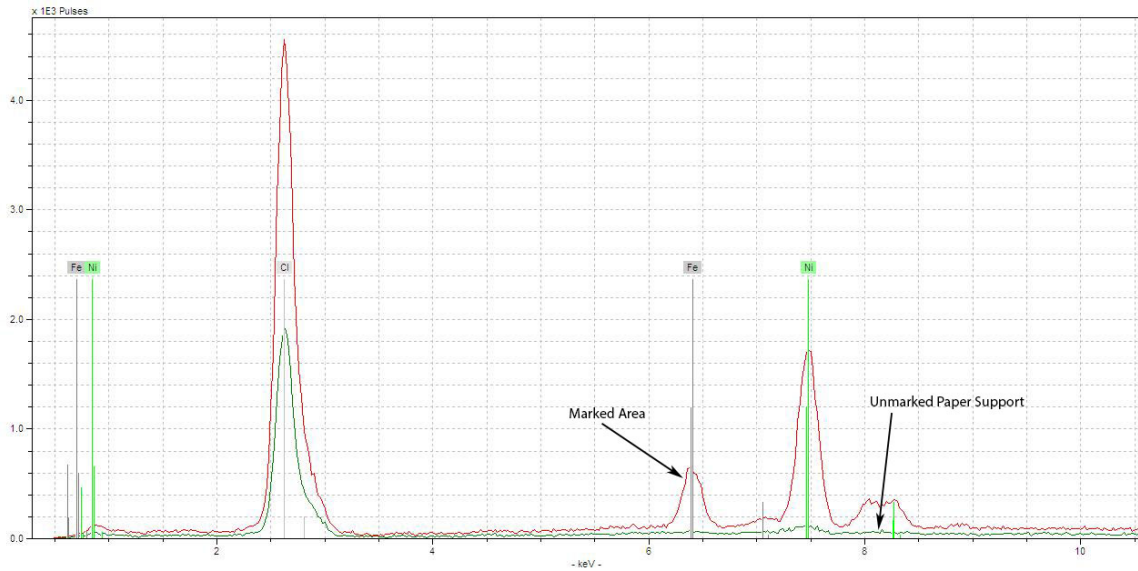
**Figure 5:** Color change of Unifax D-max and D-min areas as compared to blue Wool Standards in a microfading experiment; BWS 1 shows the most light sensitivity and Unifax D-max shows the least light sensitivity under the same amount of light exposure.

### Re-creation of the Electrolytic Process

The recipe for producing an electrolytic facsimile print seems straightforward based on the descriptions provided by the Diamond and Carr patent. An experiment was carried out to determine if the principle was truly as simple as described. Similar to the set-up for a spot test, a 6-volt battery was used to supply an electrical current. A steel pushpin was clipped to the anode cord of the battery, and a piece of filter paper soaked with a 50:50 solution of sodium chloride and catechol (both in solution in deionized water) was clipped to the cathode cord. When the pushpin at the anode was touched to the wet filter paper at the cathode a dark color was instantly formed on the paper (see Figure 6). Given the wet nature of the paper the color had the tendency to spread after contact. The color formed was immediately a dark black, but as it bled it often changed to a green or reddish tint. Further experimentation revealed that when the paper was partially dried before contact with the anode the mark made by the pushpin was less likely to bleed or to change color. Rapid drying of the paper with a hair dryer after contact with the anode also moderated the bleeding and color change. This experiment proved the simplicity of the electrolytic printing concept and shed light on the process of making a clear facsimile image. XRF of the filter paper in marked and unmarked areas revealed similar results to the sample Unifax prints. Iron and nickel were found in the pushpin, and incidents of iron and nickel greatly increased in the filter paper after marking (see Figure 7).



**Figure 6:** *Re-creation of electrolytic process: the left clip is the cathode (not attached to the filter paper in this image) and the right clip is attached to the metal point of the pushpin acting as the anode. The filter paper is resting on a watch glass and is still slightly damp, causing the written “Unifax” to have bled slightly (the “x”).*



**Figure 7:** *XRF spectra of electrolytic facsimile re-creation*

## Conclusions

Electrolytic facsimile printing has been overlooked by the dominant conservation literature on facsimile printing, however historical research has revealed that press agencies employed the technique to distribute news images between the mid-1950s and 1970s with great success. The *Daily Worker* image archive at Tamiment Library at NYU is an outstanding example of a well preserved photograph morgue from the twentieth century, and it is a model for the processing and handling of objects in other photograph morgues as they leave newspapers and enter archival collections. Current research efforts by NYU Conservation Librarian Laura McCann are focused on discovering electrolytic facsimile prints and categorizing other facsimile processes in photograph morgues around the country. It seems likely that many more collections contain these prints and that they are misidentified. The prints are significantly different in material makeup than other facsimile processes and they may warrant special attention for storage, treatment, and exhibition.

Electrolytic facsimile printing would benefit from expanded analytical research to more precisely determine the nature of the image material. Based on historical literature and initial testing it appears the image material is a metal-organic complex, similar to an ink or a dye. There are likely other components in the facsimile papers such as fillers, optical brighteners, and humectants that may also affect the preservation of the prints and warrant further research. Based on the discovery of the soluble component of the image material electrolytic facsimile prints should be protected from exposure to moisture. Microfading results indicate the prints will likely be stable in conservative exhibition conditions, although further testing should be conducted in non-accelerated conditions.

Finally, the author would like to request that readers contact her if they encounter electrolytic facsimile prints in their collections or practices. Contact information is provided at the end of the article.

## Acknowledgements

The author would like to thank Dr. Hannelore Roemich, Institute of Fine Arts Professor of Conservation Science, for support with analysis and interpretation of Unifax samples with SEM/EDS. Microfading was performed at The Metropolitan Museum of Art with the guidance of Dr. Masahiko Tsukada, Conservation Scientist, Dr. Hannelore Roemich, and Katherine Sanderson, Assistant Photograph Conservator. The author would also like to thank Laura McCann, Conservation Librarian at NYU, Hillel Arnold, staff archivist at NYU, and Nora Kennedy, Sherman Fairchild Conservator of Photographs at The Metropolitan Museum of Art, for all of their guidance and support.

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