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Research

# Sliver Recovery from Waste X Ray Photographic Films by Electro Deposition

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## ABSTRACT

Silver is a precious metal that has the highest reflectivity, as well as the highest electrical and thermal conductivity's when compared to any other metal. The waste X-ray photographic films containing 1.5 - 2 % (w/w) black metallic silver would be used for recovery and reuse. Around 18-20% of the world's silver needs are supplied by recycling photographic waste. The silver deposited was analyzed by SEM, EXD in this study. Global demand for silver remains steadily increasing; from 25,700 metric tons in 2016 to 27,000 metric tons in 2019. More than half of silver produced in the world is used in industries. Extraction of silver from the ore is expensive and harmful to the environment. X-ray technique is greatly helpful for diagnosis of patient problems and hence widely used till date. Worldwide research is going on for extraction of high purity silver from the waste X-ray films, One of the novel, simple, fast, cheap and pollution-free method developed for recovering silver from waste X-ray photographic films is electro deposition and is attempted in the present study.

**Keywords:** X-ray, Photographic film, SEM, EDX, Silver recovery

## INTRODUCTION

Silver is a rare precious, naturally occurring metal, ores of where are argentite, chlorargyrite, and pyrargyrite [1]. The most common oxidation states of silver are +1, +2, +3 and +4 for $AgNO_3$, $AgF_2$, $AgF_4$ and $K_2AgF_6$ respectively [2]. Silver has more renowned applications. One of its most significant applications is in the photographic industry. With the highest thermal conductivity and highest optical reflectivity, it is found in abundance in the waste X-ray photographic films. The waste X-ray/photographic films containing black metallic silver spread in gelatin are very good source for silver recovery compared to other types of film. [3]. Naturally occurring silver is composed of two stable isotopes, 107Ag and 109Ag, of which the former is more abundant [4, 5]. Researchers claim that silver-containing wastes like used X-ray photographic film are toxic and consider them as hazardous wastes [6]. In large doses, silver and compounds containing it lead to argyria, which results in a blue-grayish pigmentation of the skin, eyes, and mucous membranes [7]. Most households dispose these wastes into land and water bodies. The recoverable silver in the x-ray films are mostly present in the "fix" and the "bleach-fix" solutions. Most photographic and X-ray wastes contain silver thiosulfate with silver at a concentration of 5 parts per million (ppm). They are found in the fixer solution, rinse water, water baths and cleaning developer tank solutions [8]. Several technologies exist to recover silver from X-ray photographic film such as burning the film, electrolysis, metal replacement, chemical precipitation and bacterial, enzymatic methods. Except chemical methods, the other methods are expensive and time consuming to recover the silver [9]. The use of chemicals like sodium cyanide, nitric acid and organic compounds cause environmental problems, while the decomposition by microorganism is slow [10]. Ion exchange processes, reduce the silver concentration in photographic effluent to levels in the range of 0.5 to 2 mg/L. Reverse osmosis (RO) and distillation recovery process are amongst the others used [11]. The major recording medium used in radiology is X-ray film although the situation is changing with the introduction of new technologies in recent years. The film can be exposed by the direct action of X-rays, but more commonly the X-ray energy is converted into light by intensifying screens and this light is

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used to expose the film. The composition of X-ray film is plastic 60%, adhesive layer 3%, emulsion (gelatin & silver halide) 25%, super coat (toxic metal) 10%. The present study explores the feasibility of high purity silver recovery from waste X-ray films by electro deposition using sodium hydroxide with a focus on the optimization of the parameters that affect the process of silver recovery.

## MATERIALS AND METHODS

Sodium hydroxides (NaOH), Silver Nitrate, Laboratory grade were procured. Silver nitrate was used for preparing standard solutions. The quantity of silver is estimated using different concentrations of standard solutions with UV spectrophotometer. Two stainless steel plates of dimensions 14cm x 11.5cm, were used as electrodes. Required voltage is supplied by 12 volts battery with voltage regulator. Electrolysis is conducted in 5 liters glass container.

### Preparing standard solution

The standard solutions of $AgNO_3$ of different concentrations 10, 20, 30, 40, 50, 60, 70, 80, 90, 100 ppm were prepared. As one gram of $AgNO_3$ solution contains 0.6352g of silver. 100 ppm of sliver solution contains 0.1572g of $AgNO_3$. With the use of UV spectrophotometer the absorbance of each solution was found and the data was used for calculating the quantity of silver in each standard solution. The same absorbance method is used for estimating the quantity of silver in the electrolyte solution. The following table and graph is the standard silver nitrate solution and its absorbance. Standard solutions are presented in the fig.1.

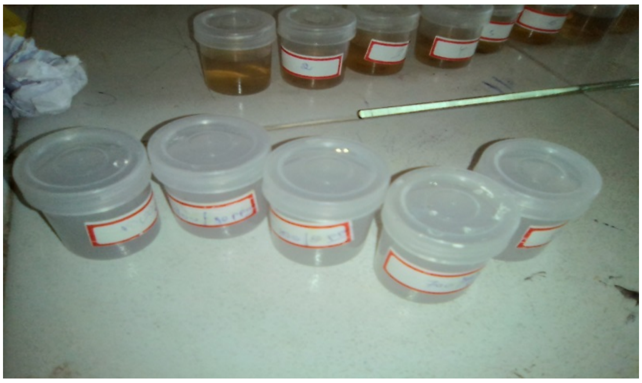

**Figure 1.** standard solutions.

## CONCLUSION

The silver got deposited on SS electrode this was determined from EDX analysis. Though the silver is deposited on plate, sodium has a higher peak since we have used 150 g of NaOH in 15 Liter solution to strip the black layer from X-ray's. In graph Concentration vs. time, we found that the concentration of silver drop is higher from 0 to 120 min and there after it is marginal. Hence the optimum time is 120 min. In graph of concentration of silver in the electrolyte vs voltage, the concentration of silver decreases suddenly at voltage from 5-6 V. It shows that the concentration of silver reduces effectively in this voltage range of (5-6V)

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