Bulletin of Electrochemistry 1 (4) July-August 1985, pp. 381-383

CHEMICAL POLISHING OF NICKEL-SILVER ORNAMENTS

MRS MALATHY PUSHPAVANAM, S JOHN AND B A SHENOI
Central Electrochemical Research Institute, Karaikudi - 623 006

ABSTRACT

A bath composition has been selected for descaling and chemical polishing of nickel-silver articles and the effect of each constituent of the bath on its polishing ability has been studied.

Key words: Chemical polishing, Ni-Ag alloy

INTRODUCTION

The alloys usually called nickel-silver, white metal or German silver are copper-nickel-zinc alloys or nickel brasses [1]. The three most common Cu-Ni-Zn alloys contain 72%, 65% and 55% copper, 18% nickel and the remainder zinc. They are used in spring applications, gift and tableware—usually silver plated, in musical and dental instruments, slide fasteners and as a base metal for moderate prized jewellery with or without plated coatings [2].

Because of the lack of ductility at room temperature, this alloy is heat treated during wire drawing operations to enhance easy processing. At these temperatures, this alloy tends to oxidise and forms an adherent oxide layer containing oxides of copper and nickel resulting in a black unattractive appearance [3, 4]. Hence, before giving any decorative treatment to the surface, this oxide layer should be completely removed and the alloy should be brought back to the original silvery white appearance. Most of the acid treatments tend to etch the surface, in addition to the heavy metal loss. Since the alloy is mostly used as a base for thin silver coating, the etch patterns will be reproduced in the final finish also. Hence, a treatment which can provide descaling as well as polishing in a single stage will be very much appreciated and work in this direction is reported in this paper.

EXPERIMENTAL

Articles like bangles, rings etc. made of nickel-silver alloy which have turned black due to heat treatment were taken for the studies. Descaling and chemical polishing were carried out in the electrolytes [5] given in Table I. The effect of the three ingredients, namely, nitric, phosphoric and acetic acids, bath temperature, water content, and agitation, on the polishing ability was studied.

The polished specimens were immediately washed and rinsed. A thin film of the white metal hydroxides still adhering to the surface was removed in order to get a clear brilliant surface and also to obtain adherent silver coating in the subsequent step. Wasing in water alone or brushing did not solve this problem. Treatment in any mineral acid, however dilute it be, reduced the lustre of the initial surface. Hence, treatment in a dilute solution of a complexing agent like EDTA, citric acid, tartaric acid etc. capable of complexing nickel and copper salts were tried. The articles after thorough washing were rinsed and transferred to the silver plating solution.

Table I: Bath compositions of various polishing solutions studied

Constituents	Solution I		Solution II		Solution III		Solution IV	
	Vol %	Conc. in ml	Vol %	Conc. in ml	Vol. %	Conc. in ml	Vol. %	Conc. in ml
Sulphuric acid (Spg 1.84)	22	80	50	50	67	50	–	–
Nitric acid (Spg. 1.42)	6	20	35	35	6	5	10	10
Hydrochloric acid (Spg. 1.18)	0.25	1	–		–		–	
Chromic acid (30% w/v)	16.75	200	–		–		–	
Phosphoric acid (Spg. 1.75)	–		15	15	20	15	50	50
Acetic acid (Spg. 1.05)	–		–		7	5	40	40
Remarks	Scale still adherent		Slight polishing but surface etching noticed		No etching but polishing not up to the mark		Good polishing with slight fumes	

RESULTS AND DISCUSSION

The results obtained in different chemical polishing formulations are given in Table I. With the first bath, there was difficulty even in descaling. Higher nitric acid concentration developed dense fumes only, without any brightening action. Solution II produced bright but highly etched surface. In solution III, addition of 5 ml of acetic acid reduced etching but not completely. Addition of 10 ml of acetic acid produced black film on the surface. Solution IV produced bright surface, but this bath also produced slight fumes. A few further experiments with empirically chosen concentrations of nitric acid, having fixed the phosphoric and acetic acid contents has led to the following composition as most acceptable one keeping in view the criteria such as good polishing ability, less surface attack, and less fumes.

Phosphoric acid	50 %
Nitric acid	2 – 5 %
Acetic acid	40 – 50 %

In the above bath, the amount of phosphoric acid added had a very important function. Below 40 %, the polishing produced was nonuniform which may be attributed to the reduction in viscosity of the bath. The volume of acetic acid added had a major influence in decreasing the etching characteristics of the electrolyte. Concentration below 30 % of acetic acid produced etching and above 60 % produced dull finish and the descaling was also not complete (Fig. 1).

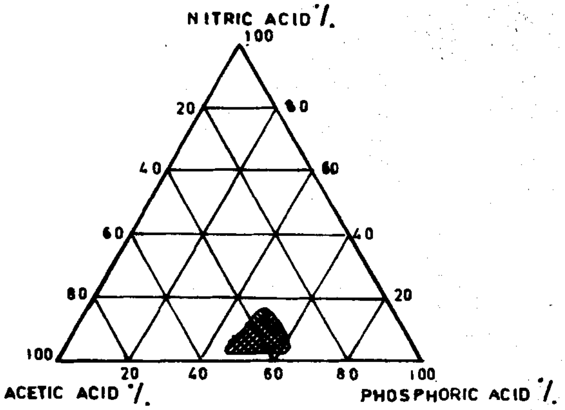

Fig 1 : Optimum composition for chemical polishing of nickel silver

Fig. 2 indicates the effect of water content in the bath in increasing the rate of dissolution of the metal. In addition, presence of water increased the nitric oxide fumes and also the temperature of the bath. Hence presence of water and nitric acid contents should be kept as minimum as possible. The optimum nitric acid concentration for producing good polishing was found to be 2 - 5 %.

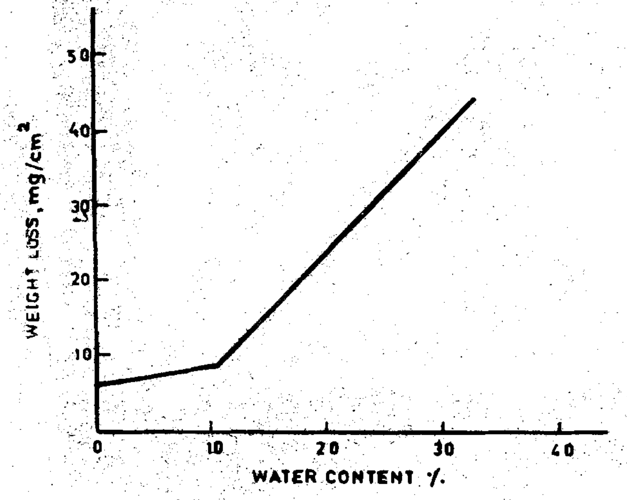

Fig 2 : Effect of water content in the chemical polishing bath on the rate of metal dissolution

Temperature of the bath had a major role in obtaining bright finish, the optimum temperature being 30° - 40° C. Higher temperature of the bath led to etching and heavy fuming. As in other chemical polishing processes, agitation of the bath, reduced the polishing action which may be attributed to the change in the thickness of the viscous layer at the metal - solution interface.

The weight loss obtained in the solution arrived at above as a function of time is given Fig. 3.

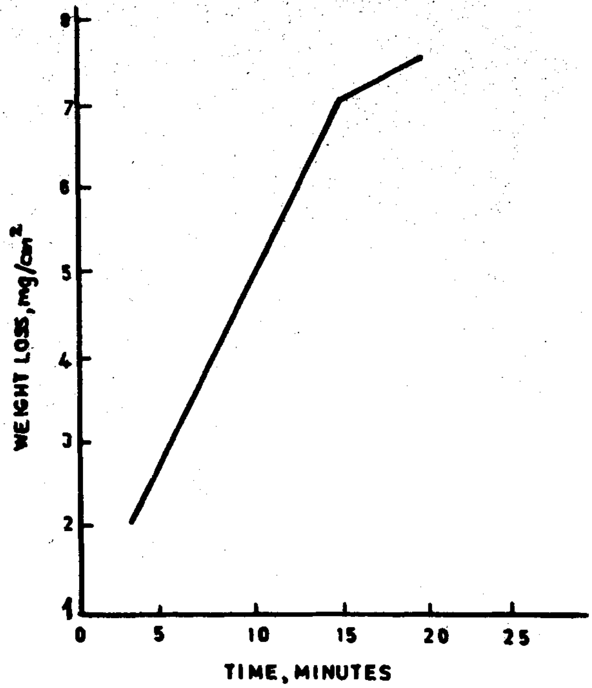

Fig 3 : Effect of duration of treatment on the rate of metal dissolution

Post treatments in various complexing agents after chemical polishing indicated that a 10 % (w/v) solution of tartaric acid is a suitable medium for removing the precipitated hydroxides. Treatments in sodium cyanide or sulphuric acid or EDTA produced either dullness or etching on the surface and in citric acid, the brightness obtained was not upto the expectation.

CONCLUSION

A bath composition consisting of 50 % phosphoric acid, 2 - 5 % nitric acid, 45 - 50 % acetic acid has been developed for descaling as well as for producing polished surface for heat treated nickel-silver articles for subsequent use in silver plating. After polishing, a treatment in 10 % solution of tartaric acid was found to be a good method in enhancing brightness of the polished surface.

REFERENCES

1. SJ Rosenberg, *Nickel and its alloys,* National Bureau of Standards Monographs, **106** (1968) 83
2. UR Evans, *The Corrosion and oxidation of metals,* Edward Arnold Ltd., (London) (1968) p. 38
3. O W Ellis, *Copper and its alloys,* American Soc for Metals, Cleaveland, Ohio (1948) p. 136
4. W Z Freund, *Corrosion of nickel and nickel base alloys.* The Electrochemical Soc. Inc., John Wiley and Sons, New York (1982) p. 288
5. P V Shigolev, *Electrolytic and chemical polishing of metals,* Freund Publishing House, Israel (1962) p. 82