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Research Article

Rhodium Plating Work in the Jewelry Industry

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Abstract – Rhodium, a platinum group metal, is the most expensive metal in this class. It is used in the jewelry sector, optical devices, automotive industry and chemical processes. It is highly preferred in coatings made in the jewelry sector. In this study, a comprehensive research has been conducted on rhodium metal, which is among the precious metals, and a study that is intended to contribute scientifically has been presented by organizing the information. Rhodium is a very valuable metal in economic and environmental terms. Coatings made with rhodium have a significant difference when compared to other metals. For this reason, coating was made with this metal under laboratory conditions. The general grinding method was chosen from existing methods such as general and pencil grinding for rhodium coating. The necessary conditions were determined to be able to make the most efficient coating. The necessary surface preparations for coating and the steps to bring it to environmental conditions were carried out. Rhodium coating was applied to the selected plate and earring surfaces in the school laboratory. As a result of the coating, materials with white and shiny surfaces were obtained.

Keywords – Jewelry Industry, Metal, Rhodium, Coating, Grinding.

I. INTRODUCTION

Rhodium is an important metal that is highly durable, hard and can provide reflective properties to the material it is used in. Rhodium, which is rarely found in the world, is among the precious metals with its properties when compared to other platinum group elements. Rhodium plating has been used commercially since the beginning of the twentieth century. Known as a platinum group metal, rhodium is highly resistant to corrosion. It has a brighter and more intense white color than white silver. The tarnishing seen in silver plating is not seen in rhodium plating. For these reasons, it is widely used for plating purposes in the jewelry sector [1]. When the values in the metal exchange are examined today, it is determined that rhodium is gaining even more value. Another reason why rhodium plating is preferred is that it does not contain harmful chemical ingredients found in many jewelry materials sold in the jewelry sector and does not cause skin or any damage that may arise from it. When its constantly increasing price and the advantages provided by its use are evaluated, it has a large place among the most preferred coatings. There are studies in the jewelry sector on the recovery of rhodium from waste baths or solutions that have lost their plating properties over time but contain a lot of rhodium in their structure.

Rhodium is a metal discovered in 1803 by William Hyde Wollaston from platinum ore mined in South America. The word originates from the Greek word “rhodon”, meaning rose. Wollaston found this name appropriate because the dilute solution formed during the discovery was red [1]. Rhodium is a transition group element with the symbol Rh in the periodic table and atomic number 45. Rhodium, which is also a platinum group metal, has a silvery color, hardness and corrosion resistance [2]. It has an expensive production process because it is found with platinum group metals (platinum, gold, silver, palladium) as an ore and the separation process is difficult. For this reason, it is a more valuable metal [3]. Today, it has started to be preferred in various areas due to its competition with gold. Rhodium is a metal with high reflective properties, hard and durable. It is found in very small amounts in nature. It does not oxidize under high temperatures under atmospheric conditions. Although it has a higher melting point than platinum, it also has a lower density. While it is inert in air and acids, it can react violently with chlorine, bromine trifluoride, bromine pentafluoride and fluorine monoxide. Although it cannot be dissolved with nitric acid, it can be dissolved in trace amounts in a mixture of nitric acid and hydrochloric acid (aqua regia) [4-5].

Rhodium, which is rarely found on Earth, can be produced from only 10 mines. Rhodium is found in nickel-copper deposits in South Africa and Canada, and it is found in North Africa as a free metal. It is also highly mined in Russia, America and South Africa [7]. Rhodium metal is found together with palladium, platinum, silver and gold ores. It is mostly formed as a by-product of mining of nickel and platinum. It is not easy to purify and separate from other precious metals due to its complex structure. For these reasons, the production process is quite difficult. At the same time, this situation limits the amount of use [8]. Until the mid-1970s, classical precipitation-dissolution processes were used as the production method. Pyrometallurgical processes were also used. Rhodium is not produced by pyrometallurgical methods today due to its high melting temperature and resistance to corrosion and oxidation. Instead, enrichment is done by solvent extraction as the classical method [9].

Rhodium is widely used in industry due to its resistance to corrosion and not oxidizing despite high temperatures. It is also used in electrical contacts and as an electrical contact material with its low electrical resistance [10]. In addition, it is used as a part of the system in car catalytic converters due to its ability to eliminate nitrogen oxides. It also helps to clean exhaust gases [11]. Other areas of use include optical instruments, thermocouples, aircraft turbine engines, reflectors, and telescopes. It can also be preferred as automobile headlights and telescope mirrors. Due to the radioactive nature of rhodium, it is used in mammography devices due to its ability to create X-rays. Rhodium, which is also used in the production of nitric acid and in the hydrogenation of organic compounds, is also a suitable catalyst for formations [12]. Rhodium helps to harden platinum and palladium metals and increases corrosive resistance. For this reason, rhodium alloyed with platinum is used in aircraft engines [13]. It is used in jewelry and coating sectors for decorative purposes. It preserves its white color longer than silver plating. Rhodium is preferred both

because the rhodium plating process of gold is easy and because it provides reflective properties [14]. There is no known platinum group metal (PGM) deposit in our country. The total world PGM production is known as 470.8 tons of PGM, and the amount of rhodium is 23 tons [15]. The total world metal PGM reserve is 69Ktons, and the total proven and probable reserve is 100Ktons. The most important country in reserves is South Africa and is responsible for 91% of the total reserves. Russia, Zimbabwe, and Canada follow in the ranking. The size of the world raw rhodium market is $3.1 billion. South Africa provides 1/3 of the world exports. The market has a concentrated structure, and the number of critical countries has been determined as 6. Turkey ranks 20th in the market with its exports of $0.7 million. The USA stands out as the largest importer. More than 70% of the world imports are realized by the first four countries. Turkey ranks 25th in the market with $1.3M imports [15]. Rhodium plating is generally carried out in sulfate or phosphate type baths. Rhodium chloride salts are also used for plating. However, this causes both a decrease in brightness and an unsmooth appearance. It also accelerates corrosion on most metal surfaces, especially copper. On the other hand, it does not show any negative effect in plating applied to inert surfaces, on the contrary, it performs quite well. A smooth layer is obtained by applying an alternative primer to the material to be plated and coating using a chloride bath. However, in many coatings where an additional process such as priming is not desired, phosphate is preferred to obtain very white and reflective coatings in commercial terms, sulfate in the jewelry and industrial sectors, and sulfate-phosphate mixed baths are preferred for decorative coatings in general [16]. In this study, rhodium plating was applied to some jewelry to prevent tarnishing over time and a white color was obtained. By evaluating the coating methods applied to various metals experimentally and examining the rhodium coating studies applied by changing many parameters, a study was carried out under laboratory conditions to obtain the most qualified, economical and industrially usable coating product.rününü eldesine yönelik çalışma yapılmıştır.

II. MATERIALS AND METHOD

Materials and Equipment Used

Rhodium plating process was carried out in Yıldız Technical University-Faculty of Chemical Metallurgy Metal Plating Laboratory. In the rhodium plating technique, which is frequently preferred especially in the jewelry sector, 2 grams of rhodium is dissolved in 1 liter of distilled water to prepare the solution. Distilled water and rhodium were used to prepare the rhodium solution required for plating. A rhodium solution that is ready-made and suitable for the conditions required for plating under normal conditions and sold in the market was used in the experiment. Rhodium solution is the concentrated form of W type white rhodium plating electrolyte and has a content of 2 g/1000 mL. The glass container in which the rhodium solution is prepared is shown in Figure 1 below. To apply the rhodium coating process on the experiment, gold plates and gold earrings that were previously applied to a silver layer under laboratory conditions were used. These are called cathodes in the experimental setup. The materials to be coated are shown in Figure 1 below.

Fig.1 Cathode materials to be coated (gold plate and gold earring)

In order to assist the coating process, platinized titanium was used as an anode material in the experiment and it has an oval structure. It was chosen this way because it was desired for the coating to be the same and homogeneous at every point. The platinized titanium material usedas an auxiliary element in the experiment is shown in Fig. 2.

Fig. 2 Anode material to assist coating

To perform a coating suitable for the temperatures and voltages specified in the literature in rhodium coating processes, auxiliary equipment such as electric heater and rectifier were used.

Construction of the Experiment

A 2% rhodium solution was added to 120 ml of distilled water to form an aqueous solution. The obtained rhodium solution was heated with an electric heater until the temperature reached 50 to be suitable for the coating conditions. After the temperature control was made with a thermometer, the materials selected as anode and cathode were included in the experimental setup. First, gold-plated plates were preferred as the coating material. It was decided to make sure that the surface was smooth and to put it in the bath. The negative pole of the cables connected to the power supply in the experimental setup was attached to the anode, that is, the platinized titanium, and the positive pole was attached to the plate to be coated, which is the cathode. The required 10 A/dm^2 current was given with the power supply rectifier. The final experimental setup is shown in Fig. 3.

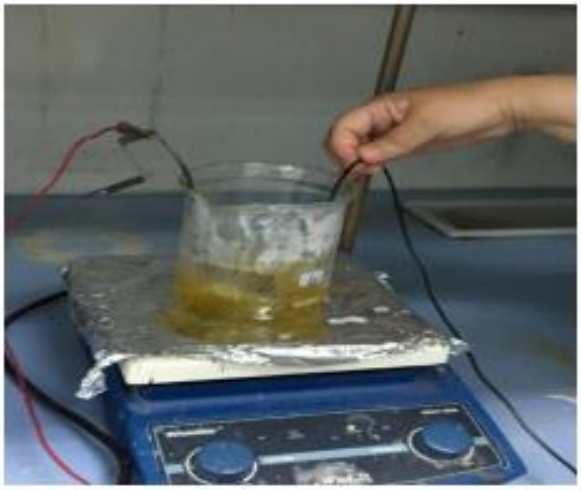

Fig.3 Final experimental setup connected to the anode and cathode

III. RESULTS

In the experimental study, the condition of the gold plate after rhodium coating is shown in Fig. 4 below

Fig.4 Coated plate

Rhodium solution of sufficient purity was used in the appropriate concentration to prevent contamination for coating. The material used before and after the application was rinsed with deionized water against contamination and losses. It was observed that the conditions specified for the experiment were suitable for coating the gold plate. A clean coating was obtained without any contamination or local accumulation. Care was taken not to touch the anode and cathode during coating. In case of any contact, a short circuit causes the coating process not to be performed. In addition to the rhodium coating applied to the plate, a gold earring with stones was also coated. The stones on the earring did not negatively affect the experiment. It was observed that it gave a similar result to the quality obtained on the smooth surface. The transition from yellow to bright white because of the coating was seen in Fig. 5.

Fig. 5 Coated earring

IV. DISCUSION

Metal or non-metal surfaces may lose their quality over time due to various reasons. For this reason, the most comprehensive surface treatment recommended is coating. In the study, the coating types applied to metals were specified with their features and compared. It was determined that the materials obtained because of coating with rhodium had a great difference from other coatings. Although it is a high-cost coating, when the features it adds to the material are evaluated, it was determined that its use in many

sectors is increasing day by day. Since rhodium has the feature of being such a valuable element, it should be subjected to several processes before, during or after the coating it is applied to provide more qualified results on metals. It was concluded that a higher quality product was obtained thanks to these processes. Before conducting an experimental study on rhodium coating, the types of baths used in the examples in the literature and the results they gave were evaluated. It was determined that baths containing sulfate, phosphate and chloride salts were generally used in the market. When the coating results of these baths were compared, it was concluded that the quality of the grinding processes applied with baths containing chloride salts in their structure was lower. Therefore, when the properties added to the surface are compared, it is suggested that more successful coatings can be obtained in the sector by using solutions formed by sulfate and phosphate salts with rhodium. In the experimental study, since it has a more attractive appearance in the market under laboratory conditions and is more preferred, rhodium plating processes were carried out on a determined stone-structured earring and a smooth plate surface by providing white rhodium solutions. The ranges of parameters such as temperature, voltage and coating time used in the examined studies were evaluated and values were selected from these ranges for the coating to be made and applied to the surfaces. As a result of the experiment, it was observed that the rhodium coating on these two surfaces, one stone-plated and the other smooth, was white, highly reflective and had a very striking appearance. The appropriate conditions required for rhodium plating were experimentally proven. It was seen that 50 temperature and 10 A/dm2 current were sufficient for a standard accumulation. The resulting rhodium-plated plate has a brighter appearance than silver. This is the evidence of the reason why rhodium plating is normally preferred over silver plating. To obtain a brighter and more efficient coating, the desired results can be obtained by increasing the current density and temperature used. Isothermal heating systems can be preferred for products with the desired brightness. pH and current control can also prevent overlooked situations.

V. CONCLUSION

When the metal economy in the world and Turkey is considered, the recovery of rhodium, a precious metal, is one of the most important issues. As a result, with the experimental study conducted on gold, it has been shown that rhodium, whose value is increasing day by day thanks to its superior properties, can be used as an equivalent to gold and silver, which are frequently preferred especially in the jewelry sector, in many areas. It is hoped that the information obtained about rhodium can be evaluated and applications that will make a great contribution to the metal sector in the future can be made.

REFERENCES

[1] A.G. Vidin. “Palladyum ve Rodyum Katkılı NiO Nanopartiküllerinin Sentezi, Karakterizasyonu ve Fotokatalitik Proseste Uygulaması ,“ Master's thesis, Konya Teknik Üniversitesi. 2022.

[2] L.J. Cabri, T. Oberthür, & R.R. Keays, “Origin and depositional history of platinum-group minerals in placers–A critical review of facts and fiction”. *Ore Geology Reviews,* vol. 144, 104733. 2022.

[3] P. Wexler, Rhodium. *In The Encyclopedia of Toxicology*, 3, pp. 126-127. Cambridge: Academic Press.2014.

[3] E. Demishkevich, A. Zyubin, A. Seteikin, I. Samusev, I. Park, C.K. Hwangbo, & G.J. Lee. “ Synthesis methods and optical sensing applications of plasmonic metal nanoparticles made from rhodium, platinum, gold, or silver”. *Materials,* vol. 16, 9, pp. 3342. 2023.

[4] A.G. Geissler, J.R. Riesterer, & B. Breit. “Stereodivergent Palladium-and Rhodium-Catalyzed Intramolecular Addition of Tosylureas to Allenes: Diastereoselective Synthesis of Tetrahydropyrimidinones”. *Organic Letters*, vol. 23(23), pp. 9168-9172. 2021.

[5] L. Hernández-López, J. Martínez-Esaín, A. Carné-Sánchez, T. Grancha, J. Faraudo & D. Maspoch. "Steric Hindrance in Metal Coordination Drives the Separation of Pyridine Regioisomers Using Rhodium (II)-Based Metal–Organic Polyhedra". *Angewandte Chemie International Edition*, vol. 60,20, pp. 11406-11413. 2021.

[6] D. A. Abarca-Quesada, C.E. Vargas-Quirós, & W.E. Vargas-Castro. "Physical properties of rhodium retrieved from modeling its dielectric function by a simulated annealing approach". *OSA Continuum*, vol. 4,12. pp. 3233-3253. 2021.

[7] I. Iavicoli, & V. Leso. " Rhodium". *In Handbook on the Toxicology of Metals*. pp. 691-728. Academic Press. 2022.

[8] K. Skibińska, D. Kutyła, X. Yang, L. Krause, M.M. Marzec, & P. Żabiński, P. "Rhodium-decorated nanoconical nickel electrode synthesis and characterization as an electrochemical active cathodic material for hydrogen production". *Applied Surface Science*, vol. 592. 153326. 2022.

[9] M. Jia, G. Jiang, H. Chen, Y. Pang, F. Yuan, Z. Zhang & H. Wang, "Recent developments on processes for recovery of rhodium metal from spent catalysts". *Catalysts*, vol. 12,11. 1415. 2022.

[10] N.A. Lanzillo, & D.C. Edelstein. "Reliability and resistance projections for rhodium and iridium interconnects from first-principles". *Journal of Vacuum Science & Technology B*, vol. 40,5. 2022.

[11] A. Cieszyńska, "Spent automotive converters – valuable sources of platinium group metals". *Current Trends in Quality Science*, 52. 2023.

[12] I. Sechopoulos, & C.S. dos Reis. "Mammography equipment. In Digitalmammography: a holistic approach". pp. 199-216. Cham: Springer International Publishing. 2022.

[13] R. Völkl, D. Freund, A. Behrends, B. Fischer, J. Merker, & D. Lupton, D. "Platinum base alloys for high temperature space applications". *Materials for Transportation Technology*, 1, 257-260. 2000.

[14] M.A. Chengwei, D.U.AN. Fei, C.H.U. Haomiao, L.I. Guang, W.A.N.G. Xiaoming, Z.H.A.O. Ziyu & W.E.N. Kai, "Thick Rhodium Plating as the Target for Cyclotron Production of Palladium-103". *Journal of Isotopes*, vol.37,1, 55-63. 2024.

[15] Platin grubu metaller yataklarının durumu, işletmeciliği ve geleceği. Istanbul Mıneral Exporters Association . USGS PGM Statistics & Information (2020)

https://www.usgs.gov/centers/nmic/platinum-group-metalsstatistics-and-information

[16] B.K. Devendra, B.M. Praveen, V.S. Tripathi, H.P. Kumar, & K.R. Chethana, The development of platinum-rhodium alloy coatings on SS304 using a pulse/direct electrodeposition technique and their application to antibacterial activity. *Journal of the Indian Chemical Society*. Vol. 99,6, 100466. 2022.