ELECTROPLATING OF COPPER ON TUNGSTEN POWDER

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***Abstract*: In order to change the properties of engineering components like increasing strength and resistance of such materials, it can be achieved by coating the components with the help of some surface materials. It helps in increasing the lifetime of parts so formed in addition to strength and other shielding properties. Tungsten is difficult to plate with other metals as it is very hard, it erodes the surface of metal with which it attempts to plate. Plating is done with the help of cold spraying process in a softer material like copper. Since tungsten is hard itself, so copper metal easily plates with it and thus yields a better surface.**

The main aim of this project is to coat the tungsten powder with copper and the material is obtained in bulk amount in a batch process. In this set of experiment the tungsten particles are encapsulated with copper by the process of electrolytic deposition using HF electro-etch pretreatment and ultrasonic agitation during electroplating.

Purpose-

Component is being coated with a surface material in order to provide more desirable material properties in the component such as increasing strength and wear resistance. The main aim of this thesis is to use different methods for coating the tungsten with copper so that it becomes suitable for different types of applications. Electroplating of metals is done for various other purposes like it can change the friction co efficient of the surface as per requirement and also increase the wear resistance. Here, the tungsten powder is being coated with copper done in a better way with the help of cold spray process.

Copper being a softer metal, favours the deformation of particles in cold spray process and thus making the bond successful.

Introduction- Metal plating has been used for different applications in order to improve the properties of engineering materials thus making them suitable for various uses. In this thesis, weare using cold spraying technique in order to adhere copper metal to tungsten powder. Cold spray is a solid-state deposition process in which particles are accelerated to very high speeds by the carrier gas which is forced through a nozzle. Upon impact, solid particles deform plastically forming an adiabatic shear instability upon contact thus breaks down the surface oxides. Due to this break, contact surface develops shear and material gets removed from the surface. The shear produced between particles and the contact surface causes the solid-state metallurgical bonding.

Various spray techniques can be used to form the bonding but the use of cold spraying is more feasible as it could be done at lowest temperatures in comparison to other conventional techniques and it is done at highest velocity as well. Due to low temperatures, the particles get plastically deform and are not melted which creates very low residual stresses in comparison to other methods and the crystalline structure does not change at low temperatures during deposition unlike other techniques where crystalline structure gets distorted due to higher temperature depositions. These methods include Plasma, High Velocity Oxygen Fuel (HVOF) in which the particles are melted and they are shrinked upon resolidification changing the entire structure and hence properties also.

Also, if coatings are done at higher temperatures , it brings much higher porosity as compared to cold spray which exhibits <1% porosity.

Requirements-

(A)Tungsten and its composition : Tungsten is a greyish-white lustrous metal which is solid at room temperature. It has the highest melting point and lowest vapour pressure of all metals and at temperatures over 1650C has the highest tenile strength. It has excellent corrosion resistance and is attacked slightly by most mineral acids. Its strength and ability to withstand high temperatures make it ideal for many commercial and industrial applications. Such properties make tungsten desirable material to coat with as its durability at high temperatures make it suitable for many applications.

The Powder used in these experiments was made by Buffalo Tungsten Inc. The particles under observation were seen as fused clusters in the form of agglomerates. They were not smooth but blocky in shape. The diameters were ranging from 5-10 and density of 3.0-5.5 g/cc.

W Composition-

Actually Tungsten alloys are 90% pure tungsten in a matrix of nickel and copper or nickel and iron. These alloying elements improve both the ductility and machinability over non-alloyed tungsten.

In a control test, W particles were kept in an epoxy resin and then ground and polished. There was a cloudy outline around tungsten particles that can be regarded as a coating in backscatter image.

Electrolytic Deposition:

Purpose- The main aim was to find out a method that would be most efficient for plating the tungsten powder with copper. Electroplating was done because of its low cost and effective in plating the materials. Firstly, electroplating was performed using a macroscopic material to determine the validity of setup and procedure. Then the method was used on the microscopic W powder to determine the impact due to change in the size of the material used.

1-Electrolyte solution: The components used to prepare the electrolyte solution were weighed using a Fisher Scientific Education Scale. These components were mixed in a beaker with the help of magnetic stirring bar and kept on stirring for 30 minutes till all of copper sulphate residue gets dissolved fully. After getting the homogenous solution, it was sealed in an Erlenmeyer flask.

2- Electroplating Procedure: In order to electroplate the particles of 100g sample, it involves 367 cycles and each cycle consist of 3 steps:-

The first step includes stirring. It can be done using an ultrasonic bath or without it. Ultrasonic bath used a corded power drill and a polypropylene paddle stirrer. The drill was made to suspend over a bath and the hole that was drilled in the copper anode so that stirring of the solution is done. The second method with no ultrasonic bath used a magnetic stirring rod to facilitate stirring. With the help of these methods, the particles are uniformly distributed in the solution and then goes back to cathode and then new particles are plated.

The second step is sedimentation. After stirring, the particles go back to the cathode. With the help of sedimentation, the new particles are being plated that lie below the top surface. As a result, the copper gets deposited on the particles below the top surface.

The last step of electroplating includes the passage of D/C between cathode and anode and hence copper ions are reduced onto the powder for one minute and then current is stopped and cycle begins again.

W Powder with HF Electro-Etch Pretreatment-

In this method, the beaker in which powder is placed during plating is kept in an ultrasonic bath made up of high-density polyethylene (HDPE) so that reaction does not take place with HF. In this method, corded drill and polypropylene paddle stirrer is used in place of a magnetic stirring rod.

Electro-etching is done in the HDPE bin. It is represented in Pourbaix diagram presented in the patent. Here, the oxide is removed from W powder without producing hydrogen. This method is similar to other powder procedures with certain exceptions.

Conclusion:-

The coated tungsten particles using HF electro-etch gives the finest results for electrodeposition of copper onto tungsten powder. This method of pretreatment is used to coat particles in small quantities and not in bulk amount. In order to coat more amount of powder, the experiment should be done for longer time. This method is the most favourable treatment for plating the particles.

References

(1)P.Yih ,"Method for Electroplating of micron Particulates with metal coatings". United States Patent 5911865, 11 April 1997.
(2)Properties of Tungsten. Buffalo Tungsten Inc. Tungsten Powder Homepage, www.buffalotungsten.com/index.html.
(3)Safety Data Sheet Tungsten Powder; Buffalo Tungsten Inc., Depew, NY , August 16,2016 (accessed March 11, 2018).
(4)A guide to the use of lead for radiation shielding (2017). Lead Industries Association, Inc.doi:10.18411/a-2017-023
(5)M Schlesinger and M. Paunovic, " Electrodeposition of Copper" in Modern Electroplating ,fifth edition ,John Wiley & Sons, Inc,2010, pp.33-78.