Journal of Engineering in Industrial Research, 2020, 1(1), 82-90

Journal of Engineering in Industrial Research

Journal Homepage: http://www.jeires.com

Original Research

Investigation of the Effect of Additives on the Morphology of Cr-WC Nano Composite Coatings

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ARTICLE INFO

Article history

Submitted: 20 July 2020
Revised: 20 September 2020
Accepted: 20 November 2020
Published: 20 December 2020
Manuscript ID: JEIRES-2012-1010

KEYWORDS

Coating
Nano composite
Nanoparticles
Tungsten Carbide
Strength

ABSTRACT

SDS and saccharin additives were used in the production of Cr-WC nano composite coatings. SDS is an anionic surfactant, and the purpose of adding it was to fertilize the surface of the particles and reduce their clumping. Saccharin was added to the solution in different amounts to reduce grain size and increase coating strength. Because large amounts of saccharin and surfactant increase the brittleness of the coating and reduce its ductility. Using the results of the effect of saccharin and SDS on the morphology of the coating, an attempt was made to design the electrolyte composition in such a way that the optimal amount of these two additives could be used for experiments. Nano composite coatings are difficult to prepare because, on the one hand, variable hydrodynamic conditions have a large effect on the amount and distribution of solid particles in the coating during electroplating, and on the other hand, nanoparticles are highly prone to clumping. Composite is the non-wetting and agglomeration of tungsten nano carbon particles during preparation of plating suspension solution. On the other hand, the ceramic-ceramic connection is a weak connection and with the slightest stress, the particles come out of their place and are placed between two surfaces and provide abrasion tools. If the nanoparticles of tungsten are evenly dispersed in the coating, the coating grows evenly and worm deposits from around the particles, holding the tungsten nanoparticles in the coating like an adhesive.

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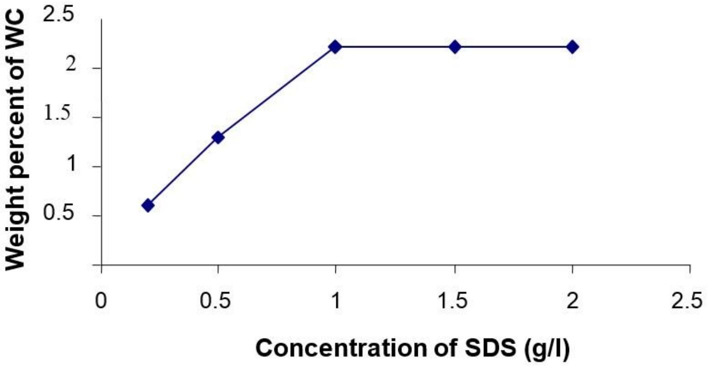
GRAPHICAL ABSTRACT



Introduction

In this study, this problem was solved by using surface activator. Therefore, the use of surface activator is mandatory and the additive of surface activator in the simultaneous address layer of particles acts as a stimulus or effect on the morphology and composition of the background phases [1-4]. Surface activation in the simultaneous coating layer can reduce the surface tension of the electrolyte and, by adsorption on the cathode particle surface, change the particle surface charge and increase the particle adsorption rate in the composite coating [5-7]. The surface activator, when dissolved in water, surrounds the particles, reducing the surface potential of the WC particles, and the gravitational force of the derivation dominates the interaction of the particles with each other, thus increasing the particle distance. When surfactants or surfactants are immersed in emulsion solution or mixtures, they have a strong tendency to form adsorption joint chapters, thus reducing surface tension and wetting and dispersion. In the non-SDS bath, WC particles are highly agglomerated and have a non-uniform distribution [8-11]. From the comparison of the above figures, it can be seen that increasing the concentration of SDS in the bath causes more presence of nanoparticles in the coating and reduces the agglomeration of tungsten carbide nanoparticles and more uniform distribution of these particles in the coating [12-14]. The reason for the increase in the weight percentage of particles in the coating with increasing SDS concentration is the increase in the surface charge of the particles and consequently the increase in their velocity towards the cathode during the illumination time due to the electrophoretic phenomenon [15-17].

In fact, SDS increases the strong adsorption and poor adsorption of particles in the coating, because the addition of SDS to the electrolyte increases the surface charge of the particles and increases the electrostatic velocity of particles towards the cathode, which increases the presence of particles on the cathode surface. . Increasing the presence of particles on the cathode surface increases the poor particle adsorption because it increases the availability of particles for placement [18-20]. The SDS acts in large quantities, like saccharin, and changes the morphology of the coating from cauliflower to a smooth surface. N. Therefore, large and agglomerated particles are removed due to hydrodynamic forces and very fine particles are absorbed and buried in the coating [21-24]. As mentioned, SDS increases the electrostatic repulsion force between particles due to the charge of the particle surface, thereby preventing the particles from agglomerating in the bath and thus causing a more even distribution and finer particles in the coating. It can also be seen from the figures d, c that although the SDS concentration has increased up to twice, the amount of particles in the coating has not increased. This observation is consistent with the EDS results of the samples [25-28].

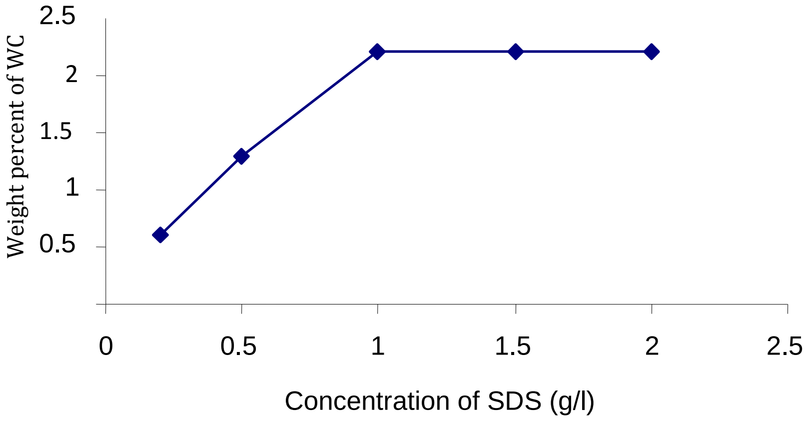


Figure 1. Effect of SDS concentration on weight percentage of tungsten carbide particles in Cr-WC coating (PH = 2.5, particle concentration 10 g / lit, 1 g / lit saccharin, duty cycle 50%, frequency 10 Hz

As can be seen in this figure, with increasing the concentration of SDS to g/lit, the presence of WC particles in the coating increased, but by adding more SDS to 2 g/lit, no effect was observed in the presence of more WC particles in the coating [29-31]. In fact, surface activators are not only a dispersant of particles in the electrolyte but also increase the simultaneous deposition [32-34]. However, one of the problems in using scavengers is that some of the scavengers that remain on the fine particles enter the coating with them and create a repulsive force between the particles and the cathode surface from the presence of more particles on the cathode surface Prevents, so in this case the amount of particles deposited are very limited [35-37]. Absorbed residues also affect the morphology of the coating and may cause adverse effects such as brittleness in the coating. Therefore, the effect of a scavenger on simultaneous deposition depends on factors such as the dispersion ability of the particles, the ionic properties of the scavengers, and the interaction of the electrode and the particles with the scavengers. Effect of saccharin additive [38-41].

In order to investigate the effect of saccharin additive on the formation of cream-tungsten nano composite coating, concentrations of 0.5, 1, 1.5 and 3 g/l saccharin in the bath were investigated. It was observed that by increasing the concentration of saccharin up to 3 g/l, the appearance of glossy coating was smoothed [42-45]. Comparing the morphology of the coating without additive and the coating containing 0.5 g/ lit of saccharin, it can be seen that the addition of 0.5 g / liter of saccharin has caused a fundamental change in the appearance of the coating and the structure of the coating is smoother and finer. Has been. The process of fine-graining and smoothing the coating surface with increasing the concentration of saccharin in the bath continues so that the coating obtained from the solution containing 3 grams per liter of saccharin has a smooth and shiny surface that this smoothing and glossing of the coating surface can be due to reduction [46-49]. The grain size of the background worm and the more uniform shape of the seeds are due to the loss of cauliflower structure. The effect of saccharin in shredding the seeds is attributed to a combination of the following factors [50-54].

(1) Increasing the reduction potential of worm ions when saccharin is present in solution and increasing the germination rate.

(2) Preventing grain growth by limiting the penetration of worm single atoms on the cathode surface.

Increasing the nucleation rate and decreasing the grain growth rate during the electrical deposition process will reduce the grain size and on the other hand, inhibiting the growth of crystal plates in the preferred directions will cause the destruction of cauliflower structure [55-57]. By increasing saccharin, the particle sedimentation rate of WC Decreased coverage. The reason for this can be explained by the fact that when the worm cover is formed from a saccharin-free bath, its surface morphology has valleys and peaks commensurate with the structure of cauliflower, and WC particles suspended in the electrolyte are trapped in the valleys. In the face of fluid hydrodynamic flows, they withstand less shear force, so they remain in the valleys and are then trapped and buried. With the addition of saccharin to the electrolyte, the structure is leveled and fine-grained [58].

As a result, increasing the concentration of saccharin reduces the weight percentage of WC particles in the coating, but since it causes a finer and more uniform distribution of particles, it can help to improve the mechanical properties of the coating because the best mechanical properties are not always obtained in the maximum amount of particles in the coating. The results show that adding a small amount of nanometer particles into the substrate, provided that they are properly distributed in it, can significantly improve the mechanical properties of the composite material [59-62].

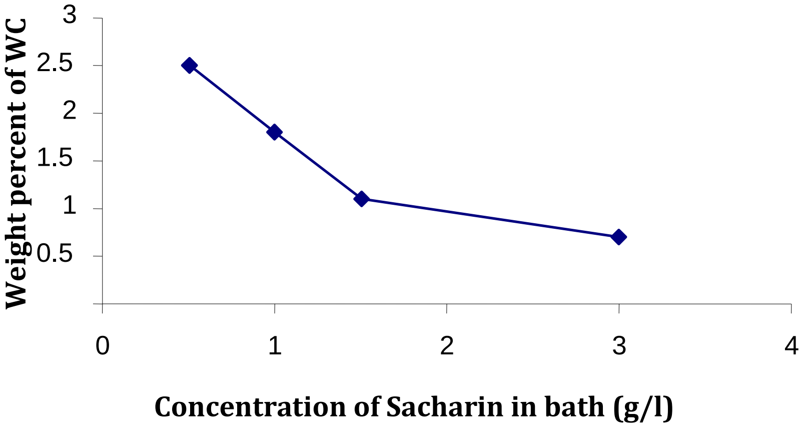


Figure 2. Effect of saccharin concentration on weight percentage of tungsten carbide particles in Cr-WC coatings (pH = 2.5, 10 g / lit particle concentration, 1 g / lit SDS, 50% working cycle, 10 Hz frequency

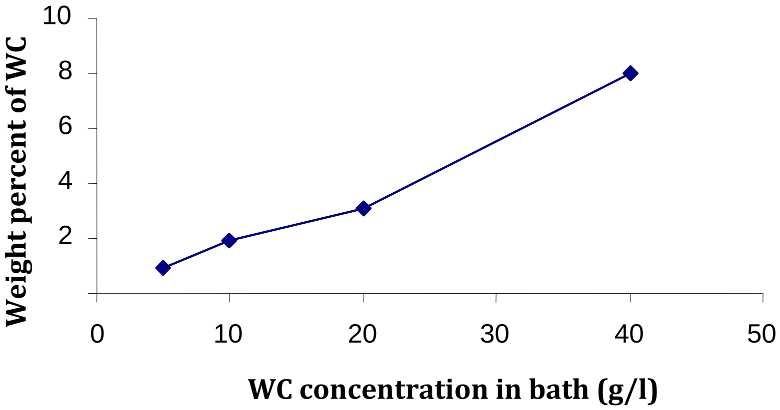


Figure 3. Effect of tungsten carbide concentration on particle weight percentage in Cr-WC coatings (pH = 2.5, g/lit SDS 1, g / lit saccharin, duty cycle 50%, frequency Hz 10

As can be seen, with increasing the concentration of ceramic particles in the plating bath, the percentage of carbon tungsten particles adsorbed in the coating increases [63-66]. With increasing concentration of ceramic particles in solution, the probability of access to particles near the cathode surface increases and as a result, by the mass transfer mechanism, more particles reach the cathode surface at a certain time and in fact the weak adsorption of particles to the cathode surface increases. Leads to the presence of more particles in the coating [67].

Conclusion

In order to investigate the effect of current density on the participation of nanometer particles of tungsten carbide in composite coatings, different coatings were prepared in different values of current densities of 2, 6, 8, 12, 15 and 20 amps per square decimeter. As can be seen in this figure, increasing the current density increases the presence of particles, and from 15 to 20 amps per square decimeter reduces the presence of particles in the coating, which is consistent with ED's results. Particle adsorption leads to the growing layer It decreases the concentration of ceramic particles on the cathode surface and a concentration gradient occurs along the penetration layer. At this stage, if the growth rate is slower than when the particles stop at the surface, the particles will move away before they join the growing layer, and if the growth rate is faster than the stopping time, the particles will settle in the growing layer. Therefore, the probability of trapping particles in the coating depends on the growth rate and hence on the flow density. According to the previously presented Celis model, the five co-precipitation steps of ceramic particles in the growing coating include the formation of ionic clouds around the particles, transfer of particles to the cathode by convective currents, passage of particles through the concentration layer by diffusion mechanism, passage of particles through the layer Electrical dualization by electrophoretic process and surface adsorption of particles to the cathode and strong adsorption by reduction of a suitable amount of ions. WC particles are covered by a number of worm ions when they reach the cathode surface. If the right amount of these ions is reduced, WC particles can be placed on the coating, so by applying the appropriate current density of particles to the cathode can be improved. As soon as the particles reach the cathode surface, the electrostatic gravitational forces between the particles and the cathode cause the particles to adhere to the cathode surface. On the other hand, due to the fact that these particles are subjected to hydrodynamic forces, in case of slow reduction, cream ions may be removed from the coating surface. Usually, cream coatings applied by electroplating are stressful and coatings produced in current density the top has cracks. In fact, in a cathode where there is a competitive reaction between hydrogen and cream metal, hydrogen is smaller and has a lower reduction potential and regenerates sooner, forming a cream hydride that is trapped in the coating and after a while decomposes and its hydrogen it will be released. When hydrogen is released, the coating shrinks and cracks.

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How to Cite This Manuscript: Masood Amiri Koshkeki. Investigation of the Effect of Additives on the Morphology of Cr-WC Nano Composite Coatings, *Journal of Engineering in Industrial Research,* (*J. Eng. Indu. Res.*), 2021, 1(1), 82-90. DOI: 10.22034/jeires.2020.262978.1010