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The Effect of Adding Saccharin to the Bath on the Hardness and Wear Behavior of the Coating

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ABSTRACT

Composite coatings are obtained by simultaneously placing non-conducting and insoluble particles inside the metal. These coatings have desirable mechanical properties and are more resistant to abrasion and corrosion than metal coatings. The degree of increase in their strength depends on the morphology of the neutral fine particles inside the composite coating and their amount. Reducing the size of the background grain as well as reducing the diameter of the reinforcing particles improves the properties of the composite coating. Good mechanical properties and oxidation resistance and good magnetic properties of these coatings have caused special attention in recent years and are widely used in various industries. Electric deposition method due to simplicity and cheapness, low process temperature, ease of achievement Nano structure as well as the production of high density and porosity-free coatings is one of the suitable methods for applying these coatings and has been of special interest to researchers in the past few decades. Nano-sized ceramic particles, the deposition of very thin coatings. They have made it possible for motor components and bearings to be highly regarded and used in micromechanical manufacturing units. Cream coatings prepared by the electrical coating method are very important in engineering parts. Cream coating has many applications due to abrasion resistance and high chemical resistance to protect the base metal against abrasion, corrosion at high temperatures and decorative applications. Cream composite coatings improve the deposition structure of the cream, for example, the abrasive and lubricating properties of the coating are improved. Very little work has been done in the field of composite cream coatings. Different particles have been used for the coating layer at the same time as the cream, but the remarkable thing is the very limited amount of particles in the composite coating.

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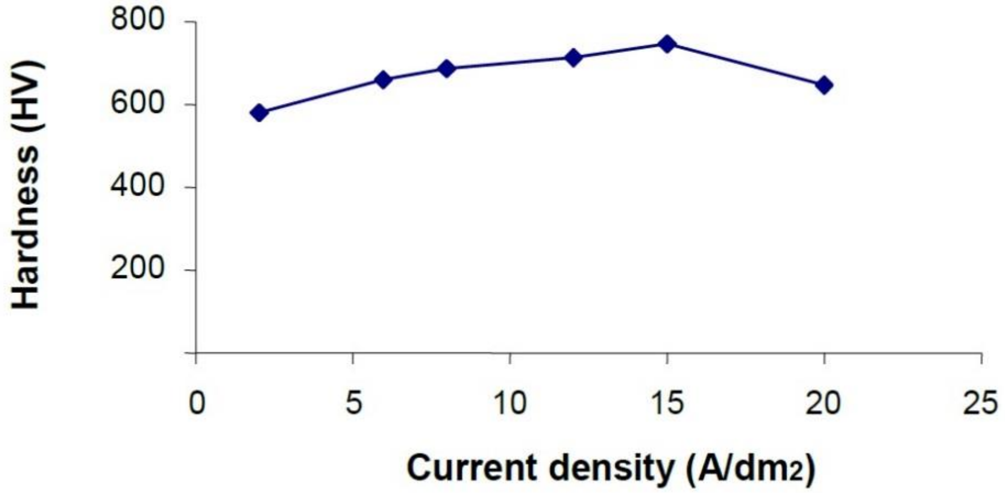
GRAPHICAL ABSTRACT



Introduction

Composite coatings have been considered since the early nineteenth century, and copper-graphite composite coatings were first tested in 1928 for car engine components [1-5]. Good mechanical properties and oxidation resistance and good magnetic properties of these coatings have caused special attention in recent years and are widely used in various industries [6-8]. The best way to create composite coatings is electroplating, the advantages of which include the following:

(1) Does not require high pressure and temperature.

(2) Concentration and distance between sediment particles can be controlled.

(3) Components do not deform. It is observed that in small amounts of saccharin, due to low hardness, plastic deformation is more and this causes the adhesion of pins and coatings.

The wavy lines and deep dents indicate adhesive wear, which indicates severe plastic deformation in the ridges on the wear surface [9-14]. Observing Figure, it can be seen that with increasing the percentage of saccharin, the wavy lines and bruises on the surface of the coating are greatly reduced and the wear level is much smoother than the sample with saccharin 0.5 g/lit. As a result, the plastic deforms less bumps on the wear surface, which leads to less adhesion and thus better abrasion resistance [15-20]. Looking at image number c, it can be seen that by increasing the amount of saccharin in the plating solution to 3 g/lit, the wear level is smoother and the abrasions due to plastic deformation are much less. This could be due to the more stiffness of the coating and therefore less plastic deformation. Although the coating hardness of a sample prepared from a bath containing 3 g/lit saccharin is higher than that of a sample prepared from a bath containing 1 g/lit saccharin, the wear rate is higher, which can lead to lower ductility [21-25]. The coating prepared from the bath contains 3 g/lit of saccharin because the low ductility of the coating leads to the germination and easier growth of cracks during wear, which is confirmed by the cracks on the wear surface [26-30].

Effect of Current Density

Figure 1 shows the micro hardness diagram of Cr-WC composite coatings in terms of different flow density values. As can be seen, the hardness of the coating increases from HV580 to HV745 and with further increase of current density, the hardness of the coating decreases to HV650, which can be explained by the particle cohesion in the composite coating [31-35].

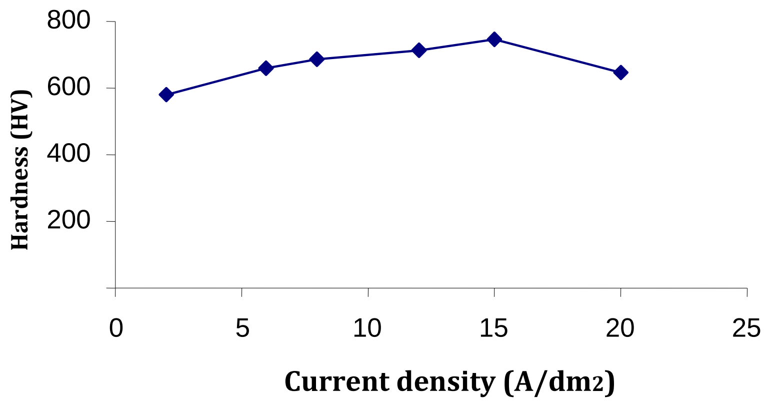


Figure 1. Micro-hardness diagram of Cr-WC composite coatings in terms of different values of flow density in the plating bath with 10 g/lit particle concentration, 10 Hz frequency, 50% duty cycle, saccharin and SDS 1 g/lit each

Figure 2 shows the wear rate of Cr-WC composite coatings in terms of different values of current density. With increasing current density up to 8, the wear rate decreases from 0.24 mg/m to 0.12 mg/m, which corresponds to the hardness of the coating [36-38]. However, with increasing the current density up to 15, despite the fact that the hardness of the coating increases, but the wear rate also increases to 0.19 mg/m [39-41]. To justify the cause of this problem, we can mention the presence of cracks in the coatings produced at high current densities (in SEM images, the morphology of the wear surface is observed in the current densities of 12 and 15 cracks) that the presence of cracks in the coating drastically reduces Abrasion resistance of coatings. In fact, the presence of cracks leads to ease of loosening of the coating because the tips of the cracks are the focal points of stress and if they are present in the crack, they grow easily and lead to the material being removed from the coating [42-45].

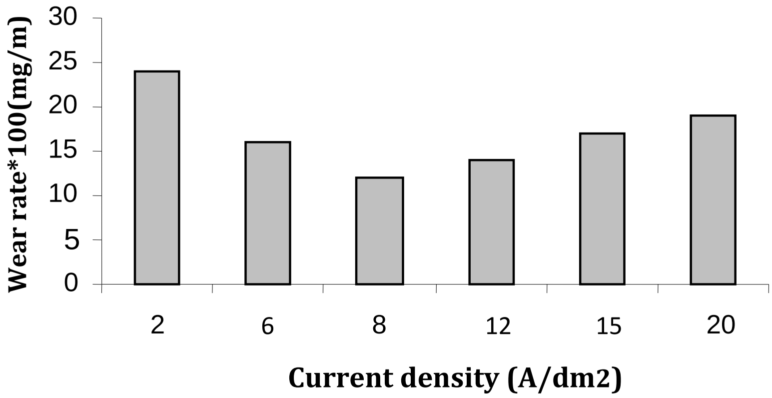


Figure 2. The wear rate of Cr-WC composite coatings in terms of flow density in the plating bath with a particle concentration of 10 g/lit, saccharin and SDS each g/lit 1, working cycle 50% and frequency Hz 10

Comparing it can be seen that the current density increases from 6 to 8, the wear level is smoother and its wear is less. The lower wear rate of this coating than the coating produced in 8 confirms this [46-50]. This can be due to the increase in field hardness due to the reduction in grain size. By increasing the current density to values greater than 8, as previously mentioned, the wear rate decreases, which may be due to the presence of cracks in the field in this range of current density range. Figure c shows the presence of these cracks on the wear surface. These cracks can lead to easier germination and growth of cracks during wear and thus increase the wear rate. Reducing the amount of WC particles at high flow density values, as well as lower coating hardness can lead to higher coating wear rates due to more plastic deformation. As can be seen in Figure C, the areas of slip and deformation of the plastic can confirm this theory [51-55].

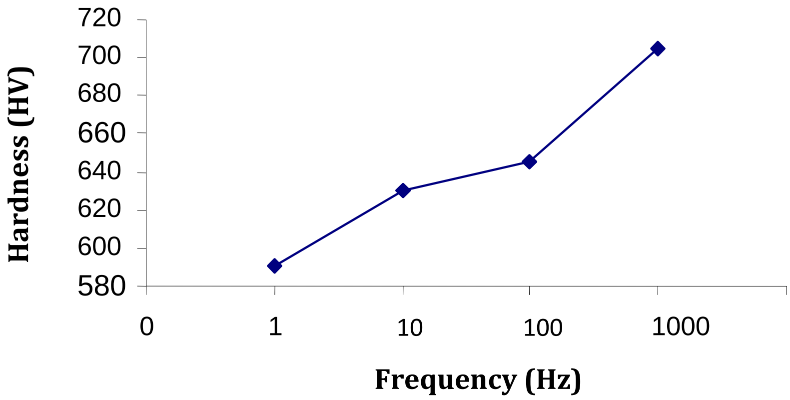


Figure 3. Micro hardness diagram of Cr-WC composite coatings at different frequencies in the plating bath with current density of 8, working cycle of 50%, particle concentration of 10 g/lit, saccharin and SDS of 1 g/lit each

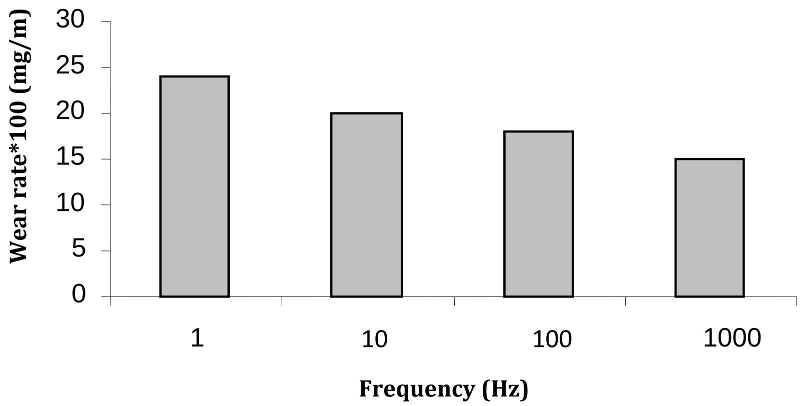


Figure 4. Abrasion rate of Cr-WC composite coatings in terms of frequency in the plating bath with current density of 8, particle concentration of 10 g/lit, working cycle of 50%, saccharin and SDS each 1 g/lit

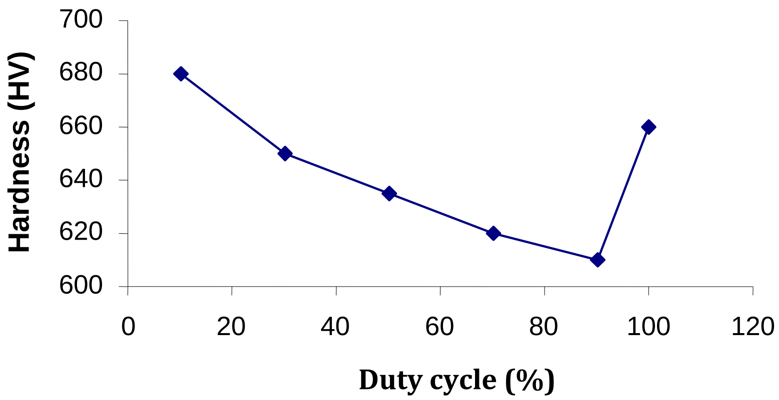


Figure 5. Micro-hardness diagram of Cr-WC composite coatings in different working cycles in the plating bath with flow density of 8, particle concentration of 10 g/lit, working cycle of 50%, saccharin and SDS of 1 g/lit each

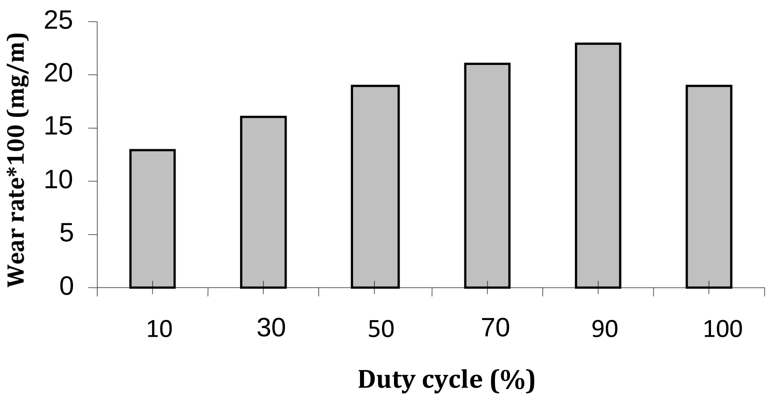


Figure 6. Abrasion rate of Cr-WC composite coatings according to the work cycle in the plating bath with current density of 8, particle concentration of 10 g/lit, frequency of 10 Hz, saccharin and SDS of 1 g/lit each

It is known that the lowest wear rate in work cycle 10 was 0.13 mg/m with the presence of particles at 2.6% by weight and hardness of HV 680 and the highest wear rate in work cycle 90 was 0.23 mg/m in the presence of the particles are 1% by weight and hardness of HV 610.
It is also noteworthy that in the work cycle of 100, despite the high hardness, ie HV 660, its wear rate has increased due to cracks in the coating surface, which cause a severe drop in wear resistance of the coating [56-63].

Conclusion

(1) By increasing the concentration of tungsten nanoparticles in the electrolyte, the deposition of these particles in the coating increases and increases the hardness and improves the abrasion resistance of the coating.
(2) With increasing the working cycle, the amount of co-precipitation of WC particles in the coating decreases and the hardness and abrasion resistance of the coating decrease.
(3) By increasing the current density up to 8 co-precipitation, the particles in the coating increase and the hardness and abrasion resistance of the coating increase. With further increase of current density from 8 to 20 due to cracking in the coating, its wear resistance decreases.
(4) Increasing the frequency from 1 to 1000 Hz increases the hardness and improves the abrasion resistance of the coating.
(5) Increasing the amount of SDS surfactant leads to increased WC co-precipitation and coating granularity, but if the amount is more than the optimal limit, it will lead to coating brittleness and reduced abrasion resistance.
(6) Adding saccharin to the electrolyte due to the reduction in grain size leads to an increase in hardness and on the other hand reduces the co-precipitation of WC particles.
(7) The best coating in terms of hardness and abrasion resistance was obtained in the following conditions: SDS and saccharin each 1 g/l, pulse frequency HZ10, duty cycle 50%.

References

[1]. B. Mansourabad, *Int. J. Adv. Stu. Hum. Soc. Sci*., 2019, 8(2): 126
[2]. H. ghe.Moniri, N. Dohniyatkar, *Int. J. Adv. Stu. Hum. Soc. Sci*., 2019, 8(2): 137
[3]. S.N. Jelodarloo, E. Nazari, Z. Hatami, K. Nouri, S. Nazari, *Int. J. Adv. Stu. Hum. Soc. Sci*., 2019, 8(2): 158
[4]. Z. Hatami, S.N. Jelodarloo, E. EmamgholizadehTakle, E. Nazari, A. Hatami, *Int. J. Adv. Stu. Hum. Soc. Sci*., 2019, 8(2): 168
[5]. A. Bozorgian, S. Zarinabadi, A. Samimi, *Journal of Chemical Reviews*, 2020, 2(2): 122
[6]. A. Bozorgian, S. Zarinabadi, A. Samimi, *Chemical Methodologies*, 2020, 4(4): 477
[7]. A. Samimi, *Progress in Chemical and Biochemical Research*, 2020, 3(2): 140
[8]. A. Bozorgian, Z. Arab Aboosadi, A. Mohammadi, B. Honarvar, A. Azimi, *Journal of Chemical and Petroleum Engineering,* 2020, 54(1): 73
[9]. S.V. Mousavi, A. Bozorgian, N. Mokhtari, M.A. Gabris, H.R. Nodeh, WA. Ibrahim, *Microchemical Journal*, 2019, 145: 914

[10]. A. Samimi, S. Zarinabadi, A. Bozorgian, A. Amosoltani, M.S. Tarkesh Esfahani, K. Kavousi, *Progress in Chemical and Biochemical Research* , 2020, 46

[11]. A. Bozorgian, *Progress in Chemical and Biochemical Research,* 2020, 3(2): 169

[12]. A. Bozorgian, Z. Arab Aboosadi, A. Mohammadi, B. Honarvar, A. Azimi, *Eurasian Chemical Communications*, 2020, 2(3): 420

[13]. A. Bozorgian, Z. Arab Aboosadi, A. Mohammadi, B. Honarvar, A. Azimi, *Progress in Chemical and Biochemical Research*, 2019, 31

[14]. N. Farhami, A. Bozorgian, *In Int. Conf. on Chem. and Chem. Process IPCBEE*, 2011, 10, 223

[15]. A. Bozorgian, NM. Nasab, H. Mirzazadeh, *World Academy of Science, Engineering and Technology International Journal of Materials and Metallurgical Engineering*, 2011, 5(1), 21

[16]. A. Bozorgian, *Advanced Journal of Science and Engineering*, 2020, 1(2): 34-39

[17]. J. Mashhadizadeh, A. Bozorgian,A. Azimi, *Eurasian Chemical Communications*, 2020, 2(4): 536

[18]. A. Bozorgian, M. Ghazinezhad, *J. Biochem. Tech,* 2018, 2, 149

[19]. A. Bozorgian, *International Journal of New Chemistry*, 2021, Articles in Press

[20]. A. Bozorgian, *Polymer*, 2012, 2: 3.

[21]. A. Bozorgian, S. Zarinabadi, A. Samimi, *Journal of Chemical Reviews*, 2020, 2(2): 122

[22]. E. Opoku, *Journal of Chemical Review*, 2020, 2(4): 211

[23]. A. Bozorgian, *Chemical Review and Letters.*, 2020, 3(2): 79

[24]. A. Pourabadeh, B. Nasrollahzadeh, R. Razavi, A. Bozorgian, M. Najafi, *Journal of Structural Chemistry*, 2018, 59(6): 1484

[25]. A. Bozorgian, *Advanced Journal of Chemistry-Section B,* 2020, 2(3): 91

[26]. K. Kavousi, S. Zarinabadi, A. Bozorgian, *Progress in Chemical and Biochemical Research*, 2020, 7

[27]. A. Bozorgian, *Chemical Review and Letters*, 2020, 3(3): 94

[28]. A. Bozorgian, N. Majdi Nasab, A. Memari, *interaction,* 2011, 1: 4.

[29]. A. Bozorgian, *International Journal of Advanced Studies in Humanities and Social Science,* 2020, 9(3): 229

[30]. M. Biedermann, J. Ingenhoff, M. Zurfluh, L. Richter, T. Simat, A. Harling, W. Altkofer, R. Helling, K. Grob, Food Addit. Contam. 495 Part A. Chem. Anal. Control. *Expo. Risk Assess.,* 2013, 30: 885

[31]. A. Bozorgian, *International Journal of Advanced Studies in Humanities and Social Science,* 2020, 9(3): 205

[32]. A. Bozorgian, *Advanced Journal of Chemistry, Section B: Natural Products and Medical Chemistry,* 2021, 3(1): 54

[33]. M. Esmaeili Bidhendi, Z. Asadi, A. Bozorgian, A. Shahhoseini, MA. Gabris, S. Shahabuddin, R. Khanam, R. Saidur, *Environmental Progress & Sustainable Energy,* 2020, 39(1): 13306.

[34]. A. Bozorgian, *International Journal of New Chemistry,* 2021, Articles in Press

[35]. M. Bagherisadr, A. Bozorgian, *International Journal of Advanced Studies in Humanities and Social Science,* 2020, 9(4): 252

[36]. A. Bozorgian, *International Journal of Advanced Studies in Humanities and Social Science,* 2020, 9(4): 241

[37]. M Bagheri Sadr, A Bozorgian, *Journal of Chemical Reviews,* 2021, 3(1): 66

[38]. A. Bozorgian, *Journal of Chemical Reviews,* 2021, 3(1): 50

[39]. M.J. Choobineh, M. Abdollahbeigi, B. Nasrollahzadeh, *Journal of Fundamental Applied Science*, 2016, 8(2S): 1150-1159

[40]. M. Abdollahbeigi, *Journal of Chemical Reviews*, 2020, 2(4): 303-319

[41]. M. Abdollahbeigi, M. Asgari, *Journal of Chemical Reviews*, 2020, 2(4): 257-272

[42]. M. Abdollahbeigi, *Journal of Chemical Reviews*, 2020, 3(1): 284-302

[43]. M. Abdollahbeigi, M.J. Choobineh, B. Nasrollahzadeh, *Australian Journal of International Social Research*, 2015, 1(5): 1-6

[44]. M. Abdollahbeigi, *DAV International Journal of Science,* 2015, 4(2): 47-52

[45]. M.J. Choobineh, B. Nasrollahzadeh, M. Abdollahbeigi, Investigation of Contact Resistance Effect on Finned Pipes under Natural and Forced Convection, *DAV International Journal of Science*, 2015, 4(2): 58-76.

[46]. B. Nasrollahzadeh, M.J. Choobineh, M. Abdollahbeigi, Investigation of Hydrate Formation Kinetics and Mechanism of Inhibitors Effect, DAV International Journal of Science, 2015, 4: 49-56.

[47]. M. Abdollahbeigi, M.J. Choobineh, B. Nasrollahzadeh, Nano Catalyst, Operation Mechanism and Their Application in Industry, Australian Journal of International Social Research, 2015, 1(5): 1-6.

[48]. M. Abdollahbeigi, M.J. Choobineh, B. Nasrollahzadeh, *Investigation of Molecular Structure in Gas Hydrate, Science road Journal*, 2015, 3(12): 74-79

[49]. N. Kayedi, A. Samimi, M. Asgari Bajgirani, A. Bozorgian, *South African Journal of Chemical Engineering*, in press

[50]. A. Samimi, S. Zarinabadi, A.H. Shahbazi Kootenaei, A. Azimi, M. Mirzaei, *South African Journal of Chemical Engineering*, 2020, 31, 44-50

[51]. A. Samimi, S. Zarinabadi, A.H. Shahbazi Kootenaei, A. Azimi, M. Mirzaei, *Eurasian Chemical Communications*, 2020, 2(1): 150-161

[52]. A. Samimi, S. Zarinabadi, A.H. Shahbazi Kootenaei, A. Azimi, M. Mirzaei, *Eurasian Chemical Communications*, 2020, 7(5): 681-691

[53]. A. Samimi, S. Zarinabadi, A. Bozorgian, A. Amosoltani, M. Tarkesh, K. Kavousi, *Progress in Chemical and Biochemical Research*, 2020, 3(1): 46-54

[54]. A. Samimi, S. Zarinabadi, A.H. Shahbazi Kootenaei, A. Azimi, M. Mirzaei, *Journal of Medicinal and Chemical Sciences*, 2020, 3: 79-94

[55]. A. Samimi, S. Zarinabadi, A.H. Shahbazi Kootenaei, A. Azimi, M. Mirzaei, *Chemical Methodologies*, 2020, 4(4): 378-399

[56]. A. Samimi, S. Zarinabadi, A.H. Shahbazi Kootenaei, A. Azimi, M. Mirzaei, *Chemical Methodologies*, 2020, 4(1): 852-864,

[57]. A. Samimi, M. Samimi, *International Journal of Advanced Studies in Humanities and Social Science*, 2020, 9(3): 195-204

[58]. A. Samimi, *Progress in Chemical and Biochemical Research*, 2020, 3(2): 140-146

[59]. A. Samimi, *Progress in Chemical and Biochemical Research* , 2020, 3(2): 130-134

[60]. M. Karami, A.Samimi, M. Ja'fari, *, Progress in Chemical and Biochemical Research,* 2020*,* 2 (3): 144-150

[61]. A. Samimi, S. Zarinabadi, A.H. Shahbazi Kootenaei, A. Azimi, M. Mirzaei, *JCR*, 2019, 1(3): 164-182

[62]. D. Mohammadnazar, A. Samimi, *JCR*, 2019, 1(4): 252-259

[63]. D. Mohammadnazar, A. Safavian, O. Mayeli, A. Samimi, *JARTE*, 2018, 2(12): 101-110

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