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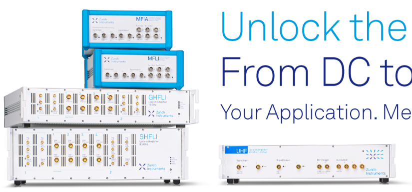
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Effect of Process Parameters on Microhardness of SS304 Coated with Blended TiO_2/ZnO

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Abstract. The material SUS304 has versatile applications in mechanical engineering field as well as other day to day appliances. It is used in food industry and also in heat exchangers, mufflers etc. The research work has been performed to analyze the impact of process parameters like doping percentage, calcination temperature and withdrawal speed on the hardness of metal. Sol-Gel dipcoating method was used to coat the blended TiO_2/ZnO nanomaterials. Automatic dip coating set up was used to control the withdrawal speed. The results show that calcination temperature has greater influence on hardness of material. The substrate shows maximum hardness of 212.5HV at 500°C and at 1 mm/sec withdrawal speed.

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INTRODUCTION

It is well known that hardness of any material is to resist wear, breakage and any type of scratching. Hardness of metals can be improved by various methods for example by joining two dissimilar metals [1]. Hardness can also be improved using very fine microstructures made by a melting process which has been done under high pressure and succeeded by quenching [2]. The effect of wired brass and zinc electrodes was analyzed in use of SS 304 through Wire EDM process, it proved that microhardness of the machined surfaces increased with increase in current, voltage, Ton and Toff time along with coated brass wire electrode[3].TiNfilms were deposited by reactive magnetron sputtering Process on SS 304 sample. The results showed that there was very small and uniform differences in microhardness values [4]. Researchers studied different Ti and W ratio of coating on 304 stainless steel by laser cladding. They reported that the hardness of coated material was 60HRC, which was quite higher than the hardness of the 304 steel having hardness value of about 40HRC[5]. Ni-TiO_2 was coated on SS 304 material by applying electro-deposition method (pulsed) . The results showed that samples (after giving heat treatment) displayed largest hardness value of 446.45 Hv [6]. AISI 304 stainless steel with 3 different cold working amounts was analyzed.It was reported that microhardness increases as the reduction in thickness[7].

For SS304, three methods were compared which are cold rolling , annealed salt baht bronzing (ASB), and annealed salt baht boronizing-quench (ASB-Q). It was found that the increase in time for annealing for the ASB method had not shown linear relationship with the elevation in hardness[8].The researcher reported that hardness of the heat-treated samples could be considered to be affected by austenite, carbide and martensite (very little). Hardness was related to micro hardness of ferrite austenite, carbide and austenitic phases[9].Fabrication of304 stainless steel by welding using mixture of Nickel-cobalt based fine powder with resin through microwave energy resulted Rockwell microhardness around 65-66 HRB with a negligible porosity[10].

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Different techniques are available to coat the material to improve the properties like hardness,wear resistance, corrosion resistance etc.[11], [12]. It has been realized that mixed polycrystals of ZnO and TiO_2 exhibit improved properties and high efficiency as compared to the unblended ZnO and TiO_2 materials [13-15].So TiO_2 and ZnO is blended together at the ratio of 2:3.Sol-gel dip coating method is applied to coat the substrate[16]. Automatic sol-gel dip coating set up is used to coat the substrate at the desired withdrawal speed.

MATERIAL AND METHODS

The material used for this research work is SUS304 purchasedfrom steel and alloys supplier (Pratham Steel and Alloys) from Mumbai, Maharashtra, India. The chemical composition of SUS 304 is as follows.

C% =0.060, Mn% =0.84, S%=0.03, P%=0.043, Si%=0.29, Ni%=0.01, Cr%=18.13 N%=0.043

The substrate was cut into size of 70 mm× 20mm× 2 mm by cutter. Then the samples were polished by polish paper of size of 3M. After polishing, they were put into ultrasonic bath for cleaning purpose. Absolute Ethanolwas used as cleansing agent. The bare samples after polishing and ultrasonic treatment are shown in Fig.1. For preparation of solution, Titanium isopropoxide was added to Ethyl Acetoacetate at room temperature under continuous stirring[17] . The solution was mixed in 2-methoxyethanol and the formed solution is then kept at room temperature for minimum two hours.

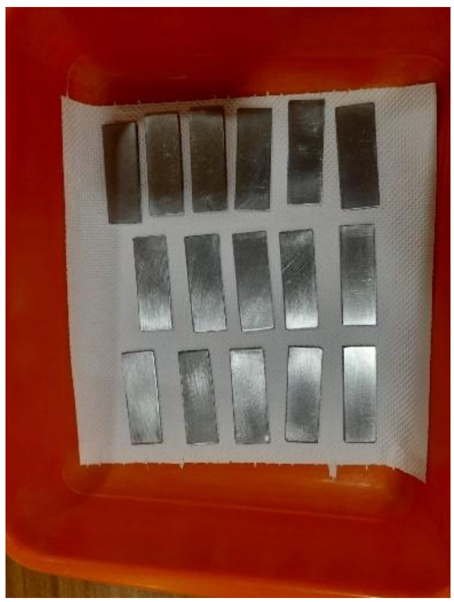

FIGURE 1. Bare samples after polishing and ultrasonic treatment

After sol preparation Zinc Acetate Dihydrate was mixed with Titanium dioxide solution. Monoethanolamine was added to Zincacetate dihydrate as it is sol stabilizer. The gel was allowed to mix in Ti sol for about one hour by using magnetic stirrer. The ratio of TiO_2 and ZnO was maintained as 2:3. The dip-coating method was applied to coat the substrate. This apparatus was used to control the withdrawal speed. The withdrawal speed was 1mm/sec and 1.5 mm/sec. The coated samples were made hot at 400°C and 500°C as long as for half hour in muffle furnace. Coated samples are shown in Fig.2.

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FIGURE 2. Coated Samples

MICROHARDNESS TESTING

Micro-hardness Vickers test was used on the surface of the specimen to evaluate and compare microhardness between coated and uncoated samples[18].The Micro-hardness Taster is shown in Fig.3.The micro-hardness tester was used(manufactured by Micro-Mach Technologies, Pune, India (Model: MMV-SA) to calculate the microhardness of all specified substrates. The light intensity was taken as 70% during the test.

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FIGURE 3. Microhardness Tester

The Vickers hardness value totally rely upon the applied load and the area created due to the indentation on the surface of substrate. The testing of hardness can be used to any type of material because of the diamond indenter, which is therefore extremely hard and resistant[19,20].

In Vickers microhardness test, the indenter load is taken as 1000 gm with a dwell time of 20 seconds. The Table 1 describes the hardness value for the different specimen.

TABLE 1. Observation Table

Sr.No.	Sample	Calcination temperature	Withdrawal speed	Vickers Hardness value
01	Bare	---	--	186.8
02	Coated	400°C	1	201.7
03	Coated	500°C	1.5	212.5
04	Coated	500°C	1	206.9

CONCLUSION

Microhardness property of SUS304 with 60% ZnO doping in TiO_2 solution by different heating temperatures and withdrawal rate was investigated. In the present work bare and coated samples were compared. The major finding of this research is the maximum hardness value is reported by sample heated at 500°C and withdrawal speed of 1.5 mm/sec, and the least hardness value is reported by bare SUS304 sample. Highest microhardness value is increased by13.75 % when compared with bare sample. At 500°C, withdrawal rate is taken as 1mm/sec and 1.5 mm/sec. The study report that, at 500°C, as the withdrawal rate is increased, the microhardness of coated SUS304 sample increases. But at both withdrawal rates(at 500°C), the microhardness is greater than bare sample. This is proved that there is definitely increment in micro-hardness due to combined effect of TiO_2/ZnO doping ratio, calcination temperature and withdrawal rate of coated samples than bare samples of SUS304.

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