American Journal of Interdisciplinary Research and Development
ISSN Online: 2771-8948
Website: www.ajird.journalspark.org
Volume 08, Sep., 2022

STUDY OF THE ATTENUATION EFFICIENCY OF (AISI-316) ALLOY MODIFIED WITH ALUMINUM IN THE PRESENCE OF SAMARIUM OXIDE DIFFUSION BARRIER

Abdullah Salih KH.
Ministry of Education, Kirkuk Edu. Directorate
askmsc84@gmail.com

Assist.Prof. Mohsin Hasan Ali
Collage of Education, Tikrit University, Iraq
muhsin.astro@tu.edu.iq

Assist.Prof. Mahmood Ahmed H.
Collage of Science, Mosul University, Iraq
dr.mahmood@uomosul.edu.iq

Annotation

The research includes the preparation of alumina coatings by cementing pack on the surface of an alloy (AISI-316) grafted with a thin layer of samarium oxide barrier diffusion. The base alloy included the metallurgical variables and mechanical surface coefficients, and finding the coefficients of linear attenuation (μ_l), and mass (μ_m), for the alloy, where the surface properties of the alloy were modified by cementing it for four different times (2-4-6-8). hour, per coating. Then study the attenuation coefficients and compare them with the theoretical and practical results of the improved alloy without the coating process, and to find out the suitability of these materials for use in the field of gamma ray radiation attenuation. These atomic parameters were measured using a source (Cs-137) emitting gamma rays with a capacity of (662 keV) and an efficiency (400 KBq), and a source (Am-241) emitting a gamma ray of energy (60 keV) and an efficiency of (74 KBq). Sodium iodide detector NaI(Tl) with dimensions (〖1.5〗 ^"× 〖1.5〗 ^") with integrated measurement system. The radiation dose rate was also calculated using linear attenuation coefficients. The results showed that the values of these coefficients are affected by the change in the coating time and type. It was found that when the coating time for the samples increased, the attenuation coefficients increased. The best results were obtained for samples coated at a time of 8 hours and in the presence of samarium oxide barrier, where there is a good agreement between the obtained values compared with the results of (ICUR), as the extent of difference between these results is less than 3%. The best results obtained for the uncoated sample, where there is a good agreement between the obtained values in comparison with the results of (ICUR), as the extent of difference between these results reaches 12%.

Keywords: Samarium Oxide,Thermal barrier,Cementation, AISA-316 Alloy, Attenuation

Introduction

At present, the surface treatments of metals and alloys allow us to obtain films or coatings with different physical and chemical properties, as aluminum-iron alloys have occupied a distinguished position in industrial applications. Therefore, the scientific and technological community is still conducting studies and research for the development of its AISA-316 alloys. Between two industrial techniques, rapid freezing and powder metallurgy, this part of the research deals with safety tests and coatings to test the alloys under study, and the manufacture and design of the coating system, which includes the package cementation, as well as the coating methods that were followed in this study.

Austenitic Stainless-Steel Food and Medical (AISA-316) is known as one of the alloys used in parts of laboratories and factories used in the manufacture of all kinds of foodstuffs and in the medical fields, as well as the use of this type of steel in parts of engines. The alloy is listed in (Specification Sheet: Alloy 316/316L (UNS S31600, S31603) W. Nr. 1.4401, [2]. The studies and research that have been carried out in the field of coatings show that the stages of sample preparation are important steps before coating because it is a factor It is essential in obtaining ideal coatings in terms of the high adhesion of the coating material, as well as the high clarity in the coating layer during microscopic examination with its different compositions. This is done by removing the oxides on the surface through a smoothing machine and using smoothing paper made of silicon carbide with different granular size and smoothness degrees starting from (180-2000), then the samples are washed with water and washing powder, and then with methanol to remove grease and suspended fats, then rinsed with acetone for quick drying, then with distilled water to obtain an (ideal) surface suitable for the coating process [2].

The coating process of the prepared samples was carried out using the cementation pack method, which is one of the widespread methods of diffusive coating. The coating was done by cementing method and for the various alloys under study dealt with in the research, where the cement powder was used, which consists of a powder containing powdered coating material, and what is meant by the coating material here is powder Pure aluminum at 25%, ammonium chloride powder (NH_4Cl) at 5% as an activator, and aluminum oxide or alumina (Al_2O_3) at 70% as a substance that helps prevent clumping of the mixture. This substance is heated to 500oC to get rid of moisture and cooled to room temperature. After that, the mixture is mixed well and placed with the sample to be painted inside a paint pot made of alumina or quartz, closed on one end, and placed inside the tube inside the oven and connected from its open end to the vacuum device, and for the time periods (8, 6, 4, 2) H, and the oven temperature is fixed at the required degree (1050 ^{o} C), and after it cools, all samples are weighed and kept under the same conditions until tests are carried out on them [4].

Because of the wide uses of gamma rays and X-rays in various fields such as medicine, agriculture, industry and nuclear physics research, many studies have been presented in this aspect about radiation attenuation. Various, living organisms are constantly exposed to ionizing radiation from natural and artificial radiation sources. Radioactive sources are categorized into two categories, natural sources and man-made sources. More than 90% of human radiation exposure is from natural sources, for example terrestrial sources that come from radionuclides in the earth's crust, air, food, water, and cosmic rays. Radiation exposure to the human population occurs primarily from medical uses of radiation and radioisotopes in health care, as well as from industrial uses of nuclear techniques, and from nuclear weapons testing. Radiation exposure can be significantly reduced by adequate safety measures and improved nuclear procedures and practices [6].

Practical Part, Results and Discussion:

Coating study: Cementation processes were carried out for AISI-316 alloy, in order to study the effects produced by cementation, and cementation in the presence of thermal barriers, through the use of high efficiency aluminum at a temperature of (1050° C) and for the time period (8 - 6 - 4 - 2) H, in atmosphere (10^{-3} torr). It is clear from the microscopic examination of the cross-section of the samples after the surface finishing operations that there is a very narrow third region separating the base alloy and the coating layer despite the presence of two distinct and different regions in thickness, and it is worth noting that the narrow region is almost devoid of sediments and it represents the region of mutual diffusion. While we note that the outer layer in the paint for the time periods (a_ 2, b_ 4, c_6, d_8) has a multi-phased appearance and is characterized by being of a light color tilted to gray and brown, and other phases appear in colors that may be dark colors and tend to black, in When the inner region has the appearance of a single phase and the colors may be brown and almost yellowish, as a result of the fact that the base alloy consists of a high percentage of nickel and chromium, compounds (aluminum - nickel), (aluminum - chromium) are formed in the outer region of the coating Figure (1-a-b) [2], The diffusion of the aluminum layer is clear during the coating and this is consistent with the quantitative and qualitative analysis scheme of the electronic scanning device (XRD-EDS) Figure (2-a-b)[2], as it is clear from Figure (3-b) that the highest peak It belongs to aluminum, and this agrees with the images of the examination (SEM) and the dispersion energy spectrum (EDS), for atoms of aluminum, as well as there are other atoms that belong to certain ratios of atoms of other elements such as chromium and others [4].

From the results we obtained, the following can be concluded:

1- The use of samarium and aluminum as a mixture inside the paint powder is useful in obtaining a coating compound of Sm_2Al instead of FeAl.
2- The use of samarium oxide as a primary coating before the annealing process does not impede the diffusion of aluminum into the surface of the alloy to form the epithelium.
3- The samarium oxide can act as a thermal barrier, thus reducing the potential for continued diffusion of aluminum to the depth of the alloy during heat treatment, thus maintaining a high concentration of aluminum at the surface to ensure composition of the protective oxide shell Al_2O_3.
4- The use of the aluminum element is useful in obtaining a coating compound rich in aluminum.
5- The possibility of using the alloy (AISI-316) in the manufacture of materials and protective shields for body tissues from radiation, and use in nuclear medicine.
6- The amount of attenuation improves significantly when the concentration of the coating material (Sm_2O_3) increases, whereby atomic properties such as attenuation coefficient, radiation dose rate, etc. depend on the concentration of the material, as these properties are affected by the increase in coating time.

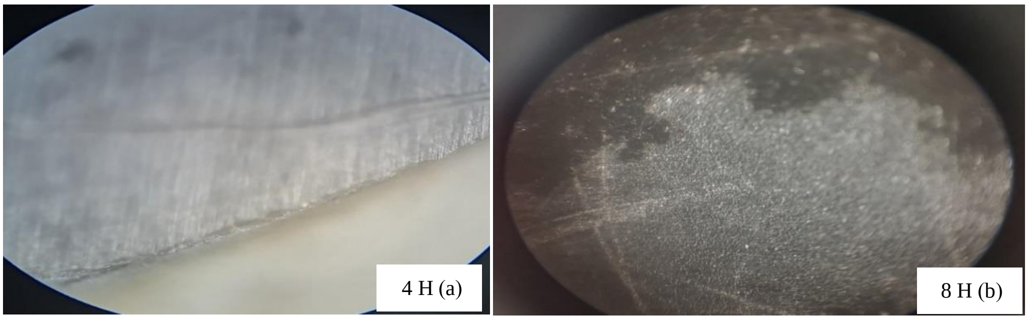

Figure (1) Microstructure of AISI-316, aluminization for period (8H).

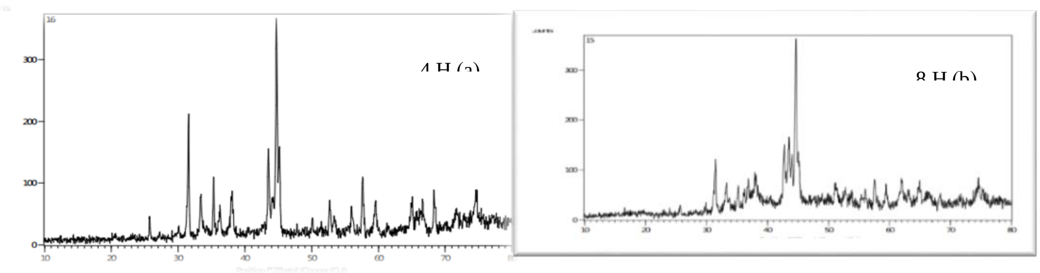

Figure (2) X-ray diffraction of AISI-316, aluminization for (4-8 /H)

American Journal of Interdisciplinary Research and Development
ISSN Online: 2771-8948
Website: www.ajird.journalspark.org
Volume 08, Sep., 2022

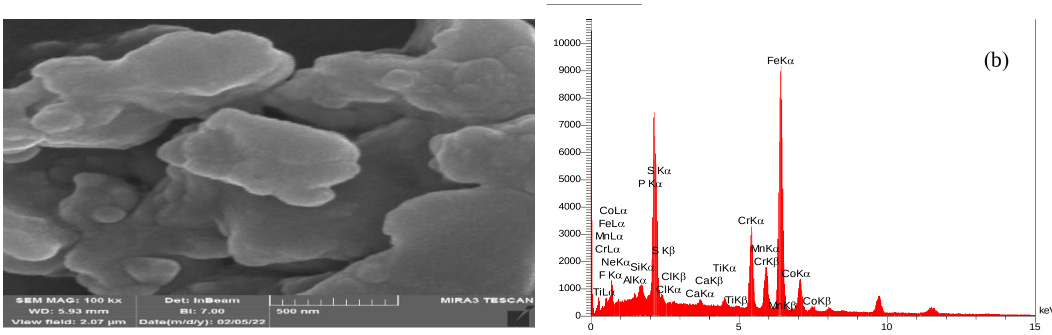

Figure (3) Microstructure and spectrograph (_SEM EDS) of AISI-316, aluminization for period (8H).

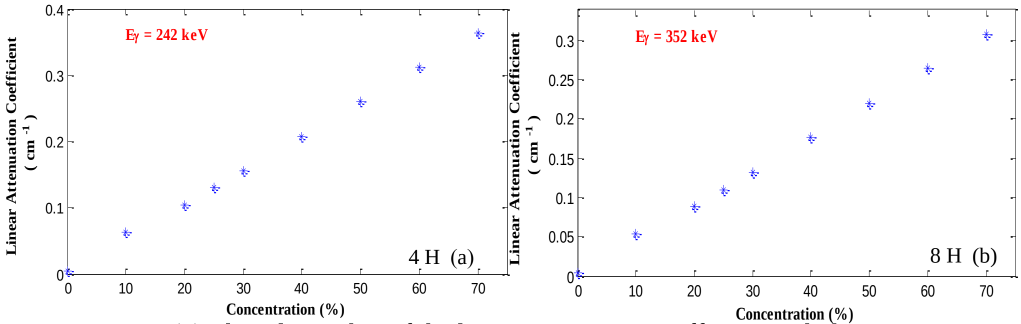

Figure (4) The relationship of the linear attenuation coefficient with the coating time

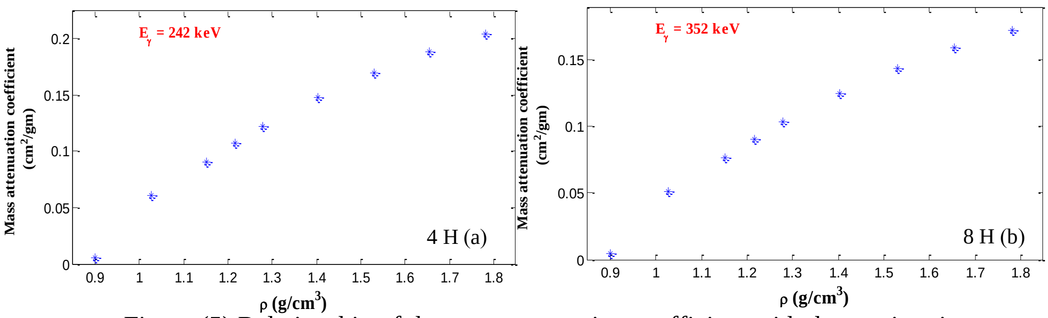

Figure (5) Relationship of the mass attenuation coefficient with the coating time

References

1. Abass Ali Saleh, (2019)" Investigating the microstructure and mechanical properties of brazed joint of inconel 738lc alloys bonded by 5ni 5ti 90al filler alloy. vol. 19.br.1, strong. 13-17.
2. Abolfazl NajiAbolfazl Naji, Zinat Esmaili, And.(2015). The Sherri A. Mason(2015) occurrence of microplastic contamination in littoral sediments of the Persian Gulf.
3. Ali Abdul-Aziz,(2018) "Durability Modeling Review of Thermal- and Environmental-Barrier-Coated Fiber-Reinforced Ceramic Matrix Composites Part I ",Materials , Vol.11, 1251; doi:10.3390 /ma11071251.

4. Ali nasiri, farhad bayat , saleh mobayen,s. Hassan hosseinni A. , (2016)" gas turbines power regulation subject to actuator constraints, disturbances and measurement noises "IEEE access,Vol.4 ,pp1-10.
5. G. Singh, M.K. Gupta, A.S. Dhaliwal, K.S. Kahlon,(2015)," Measurement of attenuation coefficient, effective atomic number and electron density of oxides of lanthanides by using simplified ATM-method", Journal of Alloys and Compounds, 619, 356–360
6. Hadi. Hasanzadeh, Ali. Abedelahi, (2011), "Introducing a simple tissue equivalent anthropomorphic phantom for radiation dosimetry in diagnostic radiology and radiotherapy ", Journal of Paramedical Sciences, Vol.2, No.4.
7. Maeda K.; Matsumoto M.; Taniguchi A. (2005). "Compton-scattering measurement of diagnostic x-ray spectrum using high-resolution Schottky CdTe detector". Medical Physics 32: 1542-7.
8. White, D. R.(1993) . " The Design and Manufacture of Anthropomorphic Phantoms " . Radiation Protection Dosimetry 49 (1/3), 359-369.