EXPERIMENTAL INVESTIGATION ON ELECTRICAL DISCHARGE ALLOYING OF AL 7075 WITH NICKEL AND MOLYBDENUM POWDER

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Abstract - *The aluminum based alloy are increasingly being used in the transport, aerospace, marine, automobile and mineral processing industries, owing to their improved strength, stiffness, surface roughness because of their high strength to weight ratio. The aluminum alloy of nickel and molybdenum coating can be tailored and engineered with specific required properties for specific application requirements and thus they have emerged as most sought after material with cost advantage and they are also known for excellent heat and electrical applications. In this project it is aimed to present the experimental results of the studies conducted regarding surface roughness properties of Al 7075 aluminium alloy with nickel and molybdenum coating. In EDM machine by using EDA (electrical discharge alloying) process, in which a mixture of 50g nickel and 50g molybdenum is coated over an alloy to get the properties. The obtained Al 7075 alloys were carefully machined to prepare the test specimens for improving surface roughness in SEM (scanning electron microscope) tests and as well as for EDAX tests. The Al 7075 alloy with a nickel and molybdenum coating resulted in improving the surface roughness. Further, the increased percentage of these alloying contributed in increased surface roughness of the alloy.*

***Key Words*: Aluminium, Nickel, Molybdenum, Electrical discharge alloying, Scanning electron microscope.**

1. INTRODUCTION

Electro Discharge Machining (EDM) is an electro-thermal nontraditional machining Process, where electrical energy is used to generate electrical spark and material removal mainly occurs due to thermal energy of the spark. EDM is mainly used to machine difficult-to-machine materials and high strength temperature resistant alloys. EDM can be used to machine difficult geometries in small batches or even on job-shop basis. Work material to be machined by EDM has to be electrically conductive.

1.1 Electrical discharge alloying

In this process the metal is removing from the work piece due to erosion case by rapidly recurring spark discharge taking place between the tool and work piece. Show the mechanical set up and electrical set up and electrical circuit for electro discharge machining. A thin gap about 0.025mm is maintained between the tool and work piece by a servo system. Both tool and work piece are submerged in a dielectric fluid. Kerosene/ EDM oil/ deionized water is very common type of liquid dielectric although gaseous dielectrics are also used in certain cases. The tool is cathode and workpiece is anode. When the voltage across the gap becomes sufficiently high it discharges through the gap in the form of the spark in interval of from 10 of micro seconds. And positive ions and electrons are accelerated, producing a discharge channel that becomes conductive. It is just at this point when the spark jumps causing collisions between ions and electrons and creating a channel of plasma. Such localized extreme rise in temperature leads to material removal. Material removal occurs due to instant vaporization of the material as well as due to melting. The molten metal is not removed completely but only partially as the potential difference is withdrawn as shown in Fig. 1.3, the plasma channel is no longer sustained. As the plasma channel collapse, it generates pressure or shock waves, which evacuates the molten material forming a crater of removed material around the site of the spark.

2. MATERIALS AND METHOD

Al 7075 alloy is an aluminum alloy, with zinc as the primary alloying element. It is strong, with strength comparable to many steels, and has good fatigue strength and machinability. It has lower resistance to corrosion than many other aluminum alloys, but has significantly better corrosion resistance than the 2000 alloys. Its relatively high cost limits its use. 7075 aluminium alloys composition roughly includes 5.6-6.1% zinc, 2.1-2.5% magnesium, titanium, chromium and other metals. It is produced in many tempers, some of which are 7075. The first developed 7075 Ws developed in secret by a Japanese company, sumitomo metal, in 1943. Al 7075 was eventually used for Airframe production in the imperial Japanese navy.

Table -1: properties of Al 7075 alloy

temperature	400 ^{0}C
Density	2810
Thermal conductivity	130W/mk
Modulus of elasticity	70-80Gpa
Specific heat	460J/^{kg0C}

3. Methodology

For performing the experiment and testing of alloy the following equipment's are used AL7075 rod with nickel and molybdenum powder, Electrical discharge alloying, Scanning electron microscope (SEM), Energy Dispersive X-ray analysis (EDX),X-ray diffraction analysis and surface roughness test

4. Experimental procedure

EDA was carried out on the surface of Al 7075 Alloy which is made in the form of a pin with 8 mm diameter and 31 mm length. 100% molybdenum (50%) and nickel (50%) powder with an average particle size of 5-10 µm was mixed in the hydro-carbon oil. A semi-automatic die-sinking EDM machine with 10A current pulse generator was used to alloy the specimens. A conventional copper electrode was connected to the negative pole for effective metal deposition on the work piece's surface. In order to avoid filtering of powder during EDA, a small tank was made in which the mixture of molybdenum and nickel powder mixed at 10 Vol % to the dielectric medium. A stirrer was additionally provided to avoid settlement of powder. The experiment was conducted for 4 minutes at three levels of peak current (6, 8 and 10A), P_{on}(25, 50 and 75 µs) and P_{off} (3, 6 and 9 µs). The micro-structural characterization was carried out using Scanning Electron microscopy (SEM), Energy Dispersive X-ray analysis (EDX).

5. Testing and Analysis

5.1 Scanning electron microscope

The scanning electron microscope (SEM) is one of the most Versatile instruments available for the examination and Analysis of the microstructure morphology and chemical Composition characterizations. It is necessary to know the basic principles of light optics in order to understand the fundamentals of electron microscopy. The unaided eye can discriminate objects subtending about 1/60° visual angle, corresponding to a resolution of ~0.1 mm (at the optimum viewing distance of 25 cm). Optical microscopy has the limit of resolution of ~2,000 A by enlarging the visual angle through optical lens. Light microscopy has been, and continues to be, of great importance to scientific research. Since the discovery that electrons can be deflected by the magnetic field in numerous experiments in the 1890s,electron microscopy has been developed by replacing the light source.

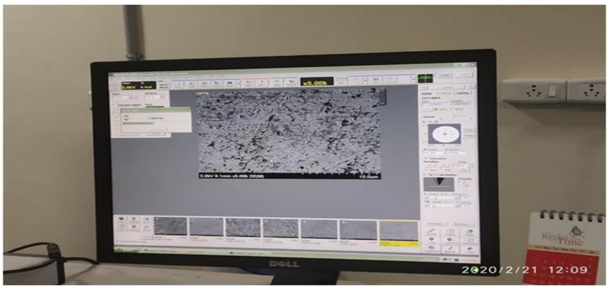

Fig-1 scanning electron microscope

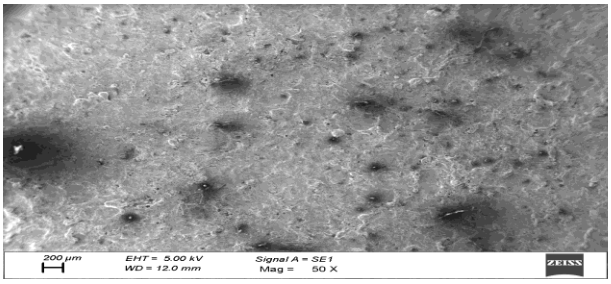

Fig -2: SEM image sample 1 at 200µm

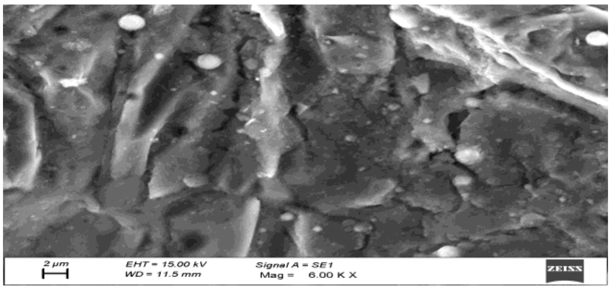

Fig -3: SEM image sample 1 at 2µm

5.2 Energy Dispersive X-ray Analysis (EDX)

Energy-dispersive X-ray spectroscopy (EDS, EDX, EDXS or XEDS), sometimes called energy dispersive X-ray analysis (EDXA) or energy dispersive X-ray micro analysis (EDXMA), is an analytical technique used for the elemental analysis or chemical characterization of a sample. It relies on an interaction of some source of X-ray excitation and a sample. Its characterization capabilities are due in large part to the fundamental principle that each element has a unique atomic structure.

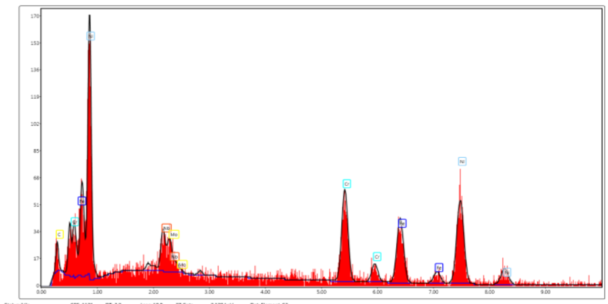

Fig-4: EDX Image sample 1

International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 07 Issue: 09 | Sep 2020 www.irjet.net p-ISSN: 2395-0072

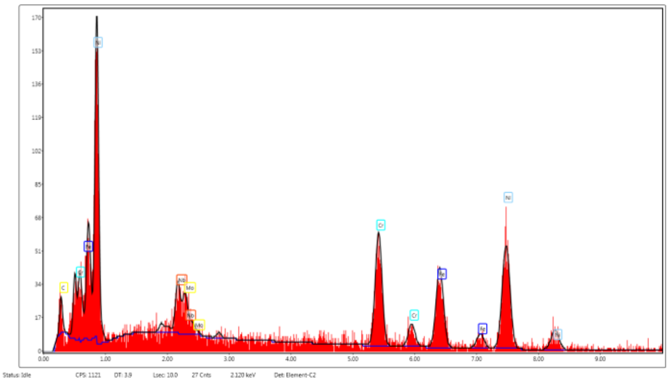

Fig-5: EDX Image sample 2

Element	Weight%	Atomic %	Error %
C k	0.78	4.71	86.67
Cr L	2.55	3.57	66.77
Fe L	5.29	6.9	32.67
Ni L	30.53	37.84	9.89
Nb L	33.95	26.59	24.2
Mo L	26.89	20.39	29.23

Table 2: EDX test result sample 1

Element	Weight %	Atomic %	Error %
C k	0	0	99.99
Cr L	0	0	99.99
Fe L	0.06	0.08	99.99
Ni L	39.57	51.26	16.15
Nb L	30.71	25.14	48
Mo L	29.67	23.53	65.95

Table 3: EDX test result sample 2

5.3 X-Ray Powder Diffraction Analysis (XRD)

X-Ray Diffraction (XRD) Analysis, is an analytical technique designed to provide more in-depth information about crystalline compounds, including identification and Quantification of the morphology of crystalline phases. This is a useful tool when trying to positively identify a contaminant or corrosion product, and for identification of foreign phases for purity analyses of crystalline powders.

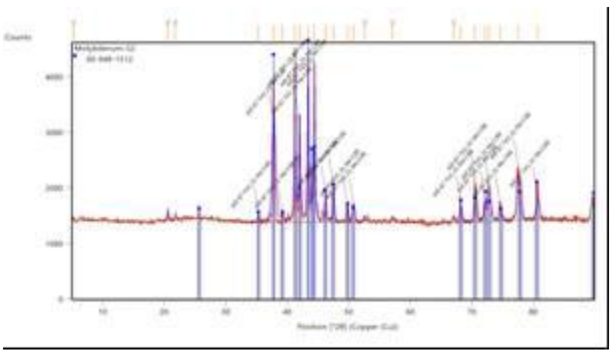

Fig-6: XRD image of molybdenum powder

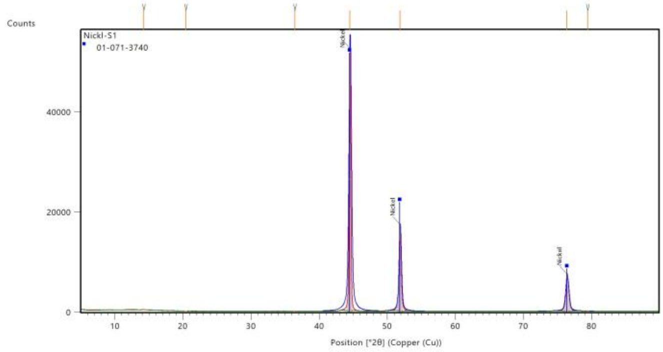

Fig -7: XRD image of nickel powder

5.4 Surface roughness test

Surface roughness, often shortened to roughness, is a measure of the texture of a surface. It is quantified by the vertical deviations of a real surface from its ideal form. If these deviations are large, the surface is rough; if they are small the surface is smooth. Roughness is typically considered to be the high frequency, short wavelength component of a measured surface.

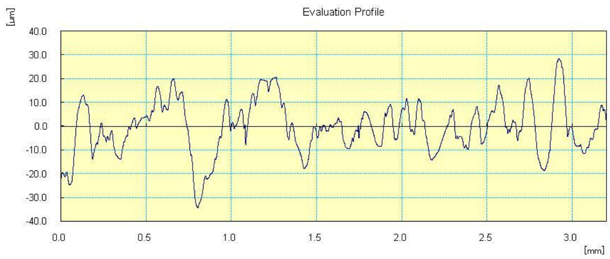

Fig -8: surface roughness graphical image

6. CONCLUSIONS

Electrical discharge alloying was successfully done over the surface of aluminium 7075 with nickel and molybdenum to change the composition and increase its hardness. Alloying was conducted with the help of RSM 9 input parameters and surface roughness was measured by instrument. Based on the result following conclusions are made. The alloyed layer thickness was found to be uniform throughout its structure with good bonding. The SEM analysis confirmed the presence of Mo-Ni along with the grain boundaries indicates uniform distribution on alloyed surfaces.

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