Effect of Surface Pre-treatment, Textured Pattern on Ti6Al4V Alloy Subjected To Fluctuating Service Conditions

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Abstract- *Due to the demand for light-weight constructions to reduce fuel consumption especially in the aerospace and automotive industries, titanium alloys stand out as the conventional choice for light weight structures. Adhesive bonding of titanium is an appealing route for joint design, also for the possibility of joining it with dissimilar materials. The realization of a strong joint depends not only on the joint design and type of adhesive, but also on the preparation of the adhering surface. In this regards many researcher have studied the static behaviour of single lap joint which depend on various factors namely adhesive thickness, adherent thickness, surface roughness, surface pre-treatment, type of joints and also influence of texture patterns on adhesion strength is consider. In this contexts investigation can be done on the effect of finest bond strength surface preparation methods for titanium such as Laser treatment, Sol-gel, Plasma spray, Chromic acid anodisation, NaOH anodisation on texture patterns produce by one of the surface texturing methods such as Laser ablation ,Micro-milling, Micro-EDM. The objective of proposed work is preliminary investigation of laser texturing on Ti6Al4V alloy and impose to different surface preparation methods .In the presented work hybrid joint is suggested by brazing welding process ,because of many advantages such as it can join variety of dissimilar metals, easily join different thickness, ease of manufacturing and repeatability. Brazing fillet at 45° to reduce the peel stress and increasing the surface adhesion for bonding. Particularly specific surface texturing is proposed by laser machining, the combine effect of finest surface preparation methods on laser textured pattern with brazed-bonded hybrid joint will be prepared to enhance the strength of adhesively bonded joints, and results compared to textured sand blasted surface..*

Keywords- Surface preparation, Surface texturing, brazing-hybrid joint.

I. INTRODUCTION

Joining technology with adhesive increasing in the field of manufacturing specifically of light weight application such as aerospace and automotive industries compared to other technology. In this regards surface finish or surface pre-treatment play a major role for securing good adhesion. It has been said that surface roughness of joining parts is very important to control the state of adhesion [1]. Adhesively bonded joint are sensitive to environmental changes and it is observed that many subtract show degradation in performance in varying moisture and temperature condition. That may significantly reduce the strength with time. Many researchers studied the performance of different metals and adhesive with respect to varying environmental conditions. Such as aluminum-epoxy joints, composite-epoxy joints etc. The review results of sand blasting on textured surface showed significant improvements up to sevenfold stronger bond compared to plain surfaces [27]. In the presented work adhesive joint is prepared by realizing grid textured pattern subtract exposed to fluctuating environmental condition. In the developed methodology initially effect of different surface preparation methods on textured pattern is studied. Adhesive bonded joint produce from best result and exposed to fluctuating environmental condition. To determine the mode of failure the results are compared with textured and non-textured sand blasted adhesive bonded joint. Farther Parametric study of variable is proposed by Optimization Method ,forming the mathematical modal between input process parameter i.e. lap length(Lo), adhesive thickness(At),textured pattern(Tp),Surface pretreatment(Sp), adhesive material thickness(Am),adherent material thickness (Amt) and shear strength as a objective function f(x). The developed mathematical model is then optimized using recently developed optimization techniques .i.e. “Jaya” Optimization Technique.

II. LITURATURE SURVEY:

Review show the various methods of surface pre-treatment on titanium alloy to improve the adhesion also identify the surface pre-treatment ,surface chemistry , properties of bond durability in adhesion studies. Particular emphasis is made on the modification of metal oxide surface [2]. Different surface pre-treatment methods have been used from long time in light weight application such as chromic acid anodisation (CCA), Sot gel treatment or phosphate-fluoride; empower the remodeling of surface chemistry and morphology [3-4]. In recent studies emphasize the great potential understanding the use of modern laser beams, laser irradiation leads to the formation of thin oxide [5-6]. Most result in the literature is for mechanical treatment such as shot-blasting [7-8].Chemical etching, flame treatment, plasma etching, UV irradiation corona discharge is widely accepted [9-10]. Several surface pretreatments have been used with different degree of success to increase surface roughness, increase surface tension, change bond strength, increase surface chemistry, and durability of composite adhesive joint. The researcher have been used many different titanium alloy as substrates in past, however Ti-6Al-4V is most extensively used one in aerospace industries [11].Durability studies of Ti-6Al-4V expose that surface preparation that produce no roughness show the poorest bond durability , significant micro roughness yield moderate to durability. The various surface pretreatment methods used for materials and titanium alloys, descriptions of their effects on the bonding strengths, surface roughness, surface tension, and durability of the these materials are presented [12] Tables I. In the presented work investigation is done on effect of different surface preparation methods impose on textured grid surface of Ti-6Al-4V is proposed, review show best suitable surface pretreatment method for titanium alloy. This work presents the investigation on effect of different surface preparation methods on laser surface textured pattern and subjected to fluctuating service conditions.

Table 1 Showing the effect of various surface treatments on surface roughness, oxide layer, bond strength and durability [12]. From the review the finest suitable surface preparation methods are chosen such as Chromic acid anodisation, NaOH anodisation, Plasma spray, Sol-gel, Laser treatment, show high bond strength for investigation on different patterns. Resent work on TI6AI4V alloy, investigated by laser texturing aim to improve surface bonding on different surface texturing are developed and concluded that 30% higher shear strength as compared to plain and sand blasted surface [27].

Da Silva et al. (2010) studied the effect of scratches or groove with two different adhesive, in this work surface pattern are studied with or without surface treatment by considering brittle and ductile adhesive and surface pattern are prepared with series of grooves which are applied with 0, 45° or 90° orientation compared to specimen without pattern, for non-treatment only acetone was used and for treatment chromic acid was chosen. And concluded that brittle adhesive show surface influence on joint strength with no chemical treatment and patterned specimens having higher strength then the specimen with without pattern with cohesive failure [14].

There are several methods for producing surface texture Chang and Wang [15] introduce a novel photolithography technique to texture aluminum oxide surface with a pit diameter which ranges from 70 to 90 μm and well-regulated spatial distribution. Most frequently used method i.e. laser ablation produce high intensity laser pulses incrementally removes minute segments of the subtract material to create desired geometric texture parameter with maximum limits of 100μm. Wong et al. [16] perform surface modification using ND-TAG pulsed laser on aluminum alloy with frequency of 20 Hz and produce non-periodic concentrated rings with uniform depth and diameter to improve the adhesion bonding quality. Malhotra et al. [17] produce micro holes on the surface of titanium alloy with 0.15 diameter and 0.95 mm depth to obtain a stronger joint. In addition to this many other texturing methods have been used such as micro milling, vibromechanical texturing (VMT), focused ion beam milling, and micro-EDM to enhance the adhesion strength.[18] summarized all the above mention surface texturing techniques and compared their typical feature . From the review laser source texturing is chosen for investigation.From the comparison number of surface texturing methods can be used for investigation as per feasibility. In proposed work Pulsed Fiber Laser Source can be use for texturing on titanium alloy and effect of different pretreatment methods on texture surface will investigate.Brazing is one of the basic methods applied for joining titanium and its alloy with titanium to titanium or titanium to other dissimilar metals [20]. In early 1950 the development of titanium brazing began an effort is made to reduce the weight of vehicle and aircraft structure [21]. Suitable for manufacturing reliable thin-wall titanium braze structure in open space also shows ability to fill small brazing gaps ≤50 μm in vacuum, temperature below 800°C, or even below 760°C. Ability to form intermetallic free micro structure at high cooling rate, low erosion interaction of filler metal with titanium base metal during brazing process and satisfactory static and impact strengths of brazed joints at cryogenic temperatures. In the proposed work braze-bonded hybrid joint is suggested with brazing at fillet. After investigating the effect of pretreatment methods on texture surface, hybrid adhesively bonded single lap joint well is produced. Brazing at 45° fillet is suggested to reduce peel stress and enhance adhesive bonding performance. To avoid the changes in the microstructure properties of adhesive and Ti-6Al-4V low temperature Titanium base brazing filler metal for titanium is chosen .The intension of using low temperature brazing filler metal is not only to achieve strong brazing joint, but also to save energy and time [21].The effect of brazing temperature on microstructure of brazed joint and adhesive depend on the nature of titanium alloy .Titanium brazing can be roughly classified into major family according to base metal. In the presented work argon furnace using Ti-base low melting filler metal is consider.

Table 1 Showing the effect of various surface treatments on surface roughness, oxide layer, bond strength and durability [12].

Treatment type	***Alloy***	***Nature of Surface treatment***	***Surface roughness***	***Oxide layer (nm)***	***Bond strength***	***Durability***
Abrasion and solvent wipe	Ti-6Al-4V	Remove mold release	Macro	-	Poor	Poor
Grit blasting	Ti-6Al-4V	Remove mold release	Macro	-	Increase	Adequate
VAST	Ti-6Al-4V	Remove mold release	Macro	-	Good	Poor
Acid etch	Ti-6Al-4V	Etch	Micro	-	Adequate poor	Poor
Alkaline etch	Ti-6Al-4V	Etch	Micro	60-200	Good	Good
Phosphate-fluoride	Ti-6Al-4V	Etch	none	20	Adequate	Poor
Modified phosphate-fluoride	Ti-6Al-4V	Etchant and oxidation	none	8	Adequate	Batter then Phosphate-fluoride
Turco	Ti-6Al-4V	Oxidising	Macro	17.5	Adequate	Adequate
Dapco treat	Ti-6Al-4V	Oxidising	Macro	6	Increase	Good
Pasajell	Ti-6Al-4V	Oxidising	Macro	10-20	Adequate	Adequate
Chromic acid anodisation	Ti-6Al-4V	Oxidising	Micro	40-400	High	Excellent
NaOH anodisation	Ti-6Al-4V	Oxidising	Micro	80-90	High	Excellent
Cathodically deposited Al2O3	Ti-6Al-4V	Oxidising			Adequate	Adequate
Plasma spray	Ti-6Al-4V	Ablation and oxidation	Micro	130	High	Excellent
Sol-gel	Ti-6Al-4V	Coupling and oxidation			High	Good
Laser treatment	Ti-6Al-4V	Ablation and oxidation	Macro		High	Poor

Table 2 summarizes the above mentioned surface texturing techniques and compares their typical feature sizes and cost for mass-production [18].

Surface texturing methods	***Typical feature size***	***Mass-production cost***
Laser ablation	100 nm	High
Pulsed Fiber Laser Source	39 mm	High
LIPMM	3 µm	High
Micro-milling	2–10 µm	High
VMT	2 µm	Fair
Elliptical vibration texturing	2.5 µm	Fair

Focused ion beam milling	10 nm	Fair
Micro-EDM	2 μm	High
Micro-forming	2 μm	Low

From comparison Ti-15Cu-15Ni show batter filler material for Ti-6Al-4V with respect to shear and tensile strength. So Ti-15Cu-15Ni is chosen a filler material for preparing hybrid joint. Strength of brazing joint depend on holding in the range of 680-700°C is has to be used for brazing titanium [21]. Brazing with or without filet angle will be analyzed in the proposed work on textured pattern. Temperature, humidity and stress are sensitive environmental conditions with respect to durability and strength of adhesive joint [31, 32, and 33]. Adhesive bonded joint may be manufactured by using variety of adherents, metal and polymer each will has diverse response to environmental factor. It is observed that many subtract show degradation in strength because of moisture diffusion. Interface strength degradation may accord owing to debonding by, corrosion ingress moisture etc. Characterization of long term response of adhesive and adhesive joint to moisture diffusion will be studied as aluminum-epoxy joint [34], composite-epoxy joint [35]. In presented work aim is to determine the effect of surface pretreatment, textured pattern, on fluctuating moisture condition and compared with non-textured condition.Currently, there are few well established design procedures for predicting fatigue load, shear strength, creak retardence by altering the geometry parameter and material such as finite element method (FEM) [23], Extended finite element method (XFEA) and taguchi approach is used to obtain optimization solution of joining process parameter [31kadam sir] .Altering the geometry of bonded joint will cause changes in stress distribution and have direct effect on stress concentration factor. Currently there is no well established design procedure for predicting failure behavior or relating changes in the material and geometric parameter to joint strength of bonded structure. However, there is limited literature available on the application of the nature -inspired algorithm to the design optimization of adhesively bonded single lap joint problem.In the investigation the finest combination of joint obtain by considering surface pretreatment on texture pattern and produce brazed-hybrid joint will optimized for strength considering nature -inspired optimization algorithms .There are many algorithm yet not used for solving such a problem such as ,Genetic algorithm ,Ant colony optimization ,Harmony search ,Particle Swarm Optimization (PSO). Optimization process include in which designer always consider certain objective such as strength, deflection, weight, wear, corrosion etc. [24-25]. Thus to find optimum values of geometric parameter of joints (lap length, adhesive thickness, texture pattern, surface pretreatment, material) for adhesive bonded joint new optimization method 'Jaya' is proposed to achieve output solution i.e. shear strength. [26]In any design problem there are number of design variable and objective function such as shear strength ,fatigue strength ,durability etc ,can be obtain. In proposed work "Jaya" Optimization method is chosen because of its capacity to solve different optimization problem effectively. This algorithm is based on the concept that the solution obtained for a given problem should move towards the best solution and should avoid the worst solution. Rao et al. (2015)

III. AIMS AND OBJECTIVES

The aim of research is to investigate the effect of different surface preparation method on textured pattern and adhesive joint prepared subjected to fluctuating environmental service condition. Farther parametric study of variable is proposed by Optimization Method, forming the mathematical modal between input process parameter. The developed mathematical model is then optimized using recently developed optimization techniques .i.e. "Jaya" Optimization Technique. The following objectives were identified to achieve the overall aim of the research.

1. To analyze most suitable surface preparation technique for Ti-6Al-4V subtracts with surface micro textured.
2. To characterize structure adhesive (Terokal® 5089) and determine suitability for Ti-6Al-4V texture surface.
3. To develop a hybrid joint by brazing on Ti-6Al-4V adhesive bonded single lap joint.
4. To conduct an experiment for determination of shear strength of hybrid (braze-bonded) joint and determining the combine effect of surface preparation methods on textured pattern.
5. To investigate failure mode of (cohesive or adhesive) specimen with (braze-bonded) hybrid joint.
6. Experimental determination of textured pattern joints strength and durability under cyclic moistening condition at different temperature.
7. Investigation of failure mode of textured pattern after moisture conditioning.
8. Analysis of moisture diffusion in adhesion joint produce by textured pattern and epoxy-based structural adhesive.
9. Investigation of the textured pattern failure surfaces, using different techniques, to determine any changes in the failure mode of the joints after moisture conditioning.
10. To identify the important input and output process parameters for Ti-6Al-4V adhesive bonded single lap joint.
11. To develop a correlation between input process

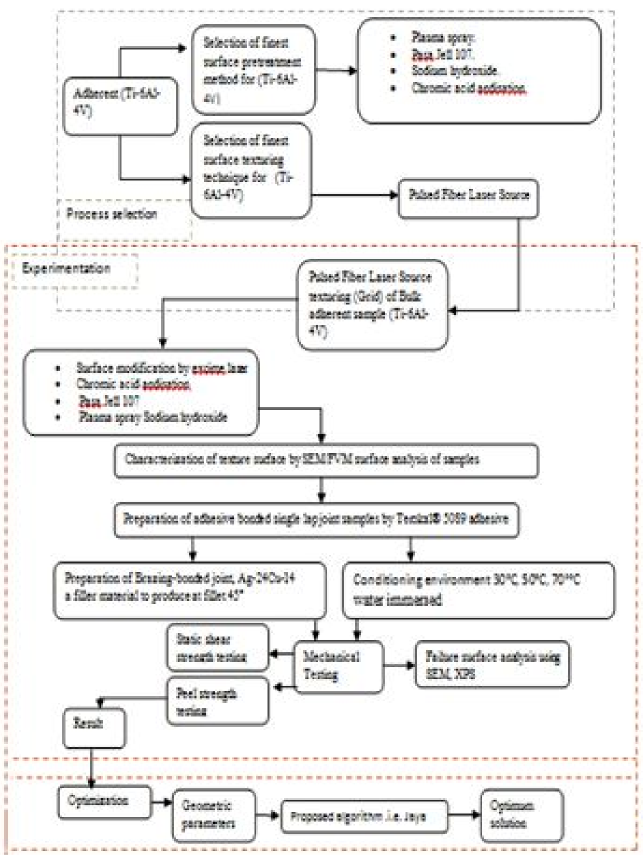
parameters and output responses.

12. To optimize the Ti-6Al-4V adhesive bonded single lap joint process parameter using new optimization techniques i.e.' Jaya' .

IV RESEARCH METHODOLOGY

Adhesive description

In the presented work textured braze-bonded hybrid joint is suggested to reduce peel stress and increasing bond strength and compared with laser textured sand blasted joint. Brazing welding process is suggested which will increase the temperature of adhesive and substrate. Epoxy-based structural adhesive Terokal® 5089 has been selected to exam adhesive in this work due to its well-known properties and its common usages in industry. It shows unique characteristics such as heat curability, including negligible shrinkage after curing, great versatility of bonding various substrates, excellent chemical resistance. It shows it maximum strength with curing temperature ranges from 155° to 200° C.



Substrate material

Most of industrial application growing demand for lighter and safer structure also joining dissimilar material together is met by high performance alloy like titanium [27]. The material used for the substrates Ti-6Al-4V this choice is made because the titanium alloy is most widely used in aerospace industries [27]. [20] Due to high reactivity of titanium for welding this is to be carried out by brazing process in proposed work. Effect of various surface treatments on Ti-6Al-4V is summarized in review. Ti-6Al-4V show prominent results on surface roughness, bond strength and durability for Chromic acid anodisation, NaOH anodisation, Plasma spray, Sol-gel, Laser treatment surface pretreatment methods [12]. For investigation surface texturing is to be done on Ti-6Al-4V substrate and effect can be evaluated by different surface pretreatment method. Physical and chemical property of Ti-6Al-4V is show in Table 4-5.

Table 5 Mechanical properties of titanium specimen Ti-6Al-4V.

Tensile strength (σt) mpa	950
Yield stress (σy) mpa	880
Elongation at failure (Єt) %	14
Modulus of elasticity , E (GPa)	113.8
Shear modulus, G (GPa)	44
Poisson's ratio (μ)	0.342

Laser surface texturing description.

For Investigation specific surface texture i.e. Grid texture is realized. And introduce to different surface pretreatment method such as Chromic acid anodisation, NaOH anodisation, Plasma spray, Sol-gel, Laser treatment. In the proposed work the surface texturing is realized using a Q-switched active fiber laser with pulse duration of about 100 ns and wave length of 1064 nm and beam diameter on plan 39µm in ambient atmosphere with any process gas. Laser surface texturing on Ti-6Al-4V will be done point to point percussion drilling operation.

Table 7 shows main characteristic of the pulse fiber laser source.

Main characteristic of the pulse fiber laser source:	*Parameter*
Laser wavelength	1064nm
Maximum average power	50W
Maximum pulse energy	1mJ
Minimum pulse duration	(FWHM)100ns
Pulse repetition rate	20–80kHz
Beam quality factor(M2)	1.7
Focal distance	100mm
Focused laser beam diameter	39 mm

The conceptual section of the designed adhesion surface is consider as grid prepared by increasing hole density on the line in both direction X and Y axes. The resulting surface pattern would become a grid show more area of contact and mechanical grip [27] .The grid texture show channels on the material surface base on linear scans. The width, depth of cavity is depending on laser energy (E). Pulse repetition rate (PRR) and number of passes, scan speed (v) .Proposed machining parameter for grid texturing are stated in Table 7.

Table 8 Laser Micro machining Parameters for Grid Surface Textures and machining Conditions Based on Linear Scanning

Laser Micro machining Parameters for Grid Surface Textures. Machining Conditions are Based on Linear Scanning		*Grid*
Pulse energy	E (mJ)	0.5
Repetition rate	PRR (kHz)	50
No. of passes	n	50
Focal position	f (mm)	-0.6
Pitch	p (mm)	250
Scanning speed	v (mm=s)	100
Machining rate	MR (cm2=min)	0.15

The width, depth of cavity, Pulse repetition rate (PRR) number of passes(s) and scan speed (v) .Simplified calculation can be derived to define grid surface texturing parameters. Farther the produce grid texture imposed to different surface preparation method to improve the adhesion.
Figure 2: Conceptual section of designed adhesion surface (a) Grid

Surface pretreatment description:

Effect of surface pretreatment methods on grid textured surface can be exam. Main idea is to check grid texture with different surface pretreatment and compared and find the best suitable surface pretreatment method. Proposed four surface pretreatment methods are selected. Procedure and effect on surface of titanium alloy substrates is explained below [22].

Plasma spray: The titanium specimens were heated to 100◦C in an oven to remove moisture, grit blasted with 180/220 Al_2O_3 grit, rinsed with a cleaner and subsequently dried. Plasma spraying was applied by spraying Hamdry 6506 TiO_2 powder. A TiO_2 coating of thickness 50 µm was produce.

Pasa Jell 107: Pasa Jell 107 was applied to grit blasted samples. It was applied for 12–15 min. After which it was rin sided with de-ionised water at room temperature. The specimens were subsequently dried and sprayed with a thin layer of the primer Redux 101 using a De Vilbiss suction feed cup spray gun, type JGA. surface show etched the existing oxide film.

4.4.3 Sodium hydroxide: Ingram and Ramani [29]. The samples anodisation were degreased in methylthylketone (MEK) for 10 min, pickled by in 15% volume of 70% nitric acid, 3% by volume of 50% hydrofluoric acid at room temperature for 30 s. They were subsequently rinsed in 2 baths of agitated deionised water for 5 min. Anodisation was performed in a 5M NaOH electrolyte at 10 V for 20–30 min. Upon removal from the solution, the samples were rinsed for 5 min in running water. The samples were allowed to dry and sprayed with a thin layer of the primer Redux 101 using a spray gun. Surface show cleaned and created a fresh oxide film.

Chromic acid andisation: Performed as described by Arnoldet al. [30] the samples were degreased in MEK for 10 min, pickled in 15% by volume of 70% nitric acid, 3% by volume of 50% hydrofluoric acid at RT for 30s. They were subsequently rinsed in 2 baths of agitated deionised water for 5 min. Anodisation was performed in an electrolyte containing 5% CrO_3 and 0.1% NH_4HF_2 at RT. The voltage was applied after the specimens were immersed in the solution and increased from 2 to 10 V at a rate of 2 V/min. The voltage held constant for 20 min. Upon removal from the solution, the samples were rinsed in the agitated deionised water and subsequently rinsed for 5 min in running water. The samples were allowed to dry and sprayed with a thin layer of the primer Redux 101 using a spray gun. Effect on surface are cleaned and created a fresh oxide.

IV. CHARACTERIZATION OF TEXTURE SURFACE

One by one different Surface pretreatment methods will be imposed on laser grid textured pieces, the topography of grid texture surface will show elevated result, and characterize by using two different methods i) scanning electron microscopy to reveal the surface morphology ii) focus variation microscopy for 3D surface analysis and surface roughness evaluation. Same analysis will be done on non-textured sand blasted specimen for comparison. SEM images of Ti-6Al-4V surface for each pretreatment method will be prepared for grid pattern. Author found similar results on grid texture show well defined dimpling, there cast generates under cuts over the surface which generates a closure on the singular square is lands. Moreover the square is lands show a fractal structure of recast layer, which may induce local differences in the surface wetting. In terms of characteristic measures, width is around 60µm and the peak to valley depth of the digs is around 450 µm [27].

Preparation of adhesive bonded joint.

Very simple geometry is chosen for testing, and overlap area is grid laser textured. The texture pieces can be bonded by single lap joint as per standard in order to compare the shear strength of adhesively bonded joint. Particularly the adherents selected of 3mm thickness, the adhesive thickness used is 0.2 mm and overlap area is 24.4*24.4 mm2 is chosen with grid texture Adhesive thickness, width, Adherent thickness, the dimensional view of a single lap joint without brazing fillet is shown in figure 3

Preparation of Brazing bonded joint.

The simple geometry is chosen with overlap length 24.5*24.5 mm2 with grid laser texturing. The joint will be manufactured with adhesive Terokal® 5089 and line thickness of 0.2mm. In the proposed work braze-bonded joint is suggested brazing at fillet to reduce peel stress. Majority of joint will be manufacture with full depth fillet using an angle of 45^0. The adherent is 3mm thick and adhesive selected for geometry Terokal® 5089. From review Ti-15Cu-15Ni show batter filler material for Ti-6Al-4V with respect to shear strength (165-200Mpa) and tensile strength (980Mpa) but only the temperature of 800°C [21]. In the proposed work titanium-base brazing is chosen because of high strength of titanium brazed. The dimensional view of a single lap joint with fillet shown in figure 4

Fillet angle effect

In the studies of adhesive lap joint several authors have prepared an adhesive spew and fillet at 45^0 to reduce the stress peak [31]. It not only related to presence of spew but also shape of geometry. Author has studied the lap joint with different angles .i.e. square ended, half triangle, entry angle, half rounded, full rounded with fillet, oval arc, etc. It is found that spew provides significantly reduction in the stress concentration at adhesive-substrate interface [32]. Ti-6Al-4V adhesively bonded joint will be manufactured with brazing 45^0 fillets at constant overlap. The adhesive used is Terokal® 5089. Result from test with fillet joint will influence stress concentration and strength of adhesively bonded joint.

VI. MECHANICAL TESTING

Static testing

Determining the tensile test of single lap joint is one of the most common methods to characterize an adhesive joint. The test is carried out by applying load in longitudinal direction. The shear strength of adhesive joint will exam by using a hydraulic testing machine able to provide load up to 100N.The strength will be influenced by laser textured joint after different surface pretreatment. Each specimen will be tested for shear stress and peel stress with braze fillet. Each joint prepared by different surface pretreatment will be tested and compared to the laser textured sand blasted surface.

Peel strength testing

All the specimens prepared by brazing at an angle of 45° will be exam for intent end of 25.4 mm with grid textured. Adhesive thickness of 0.2mm the peel stress will be conducted using floating roller peel test (ASTM D 3167-76).Peel specimen where bonded using Terokal® 5089 and brazed by Ag-24Cu-14.5In at end.

Expected results.

The effect of grid texture with different surface preparation will come with new improved results. The topography of the texture surface will show some elevated results to enhance the strength of adhesively bonded single lap joint. These topographical and morphological changes due to different surface preparation on grid texture can be investigated and compared with laser textured sand blasted joint[27].Following result can be investigated

Influence of surface pretreatment (Pasa Jell 107) on Grid laser textured surface with braze-bonded joint.
Influence of surface pretreatment (Plasma spray) on Grid laser textured surface with braze-bonded joint.

Influence of surface pretreatment (Surface cleaning by excimer laser) on Grid laser textured surface with braze-bonded joint.

Influence of surface pretreatment (Sodium hydroxide) on Grid laser textured surface with braze-bonded joint.

All result obtain after investigation will be compared with laser textured sand blasted joint. [27] Investigation on the laser surface texturing of Ti6Al4V alloy revealed some significant improvement in shear stress compared to plain sand blasted surface .Review show fully cohesive failure for the grid pattern [27]. Similar inspection is proposed with different surface preparation method on laser textured surface to enhance strength of adhesively bonded joint.

VII. MOISTURE DIFFUSION IN CYCLIC ENVIRONMENTAL CONDITIONS AND TESTING

Sample prepared by combine effect of surface pretreatment and textured pattern conditioned in water at different temperature. Mechanical properties under cyclic moisture condition exam by using different temperature batches. Batches of adhesively bonded single lap joint are conditioned in water at three different temperature and failure load will determined by testing. The sample will conditioned for multiple moisture absorption-desorption cycles. In order to observe the effect of cyclic moisture condition experiment setup is prepared. Experiment conducted on bulk specimen of adhesive joint dry in oven at constant temperature until they achieve a constant weight. For moisture conditioning samples are suspended in deionized water at constant temperature for prescribe time interval, care has to take for weighting process, balance accuracy has to be used for weighting specimen. Desorption of the conditioned sample was carried out at the same temperature as that of absorption. Tensile test will be carried out using tensile testing machine conditioned at 30° 50 ° and 70°. Absorption-desorption cycles are carried out at preselected time interval.

A set of joints will dried to constant weight in an oven at .i.e. 50° C and tensile tested to obtain unconditioned strength of joints. Similarly another joint conditioned at 50° C immerged in water for specific interval of time and tensile tested to obtain conditioned strength of joint.

Failure Surface Characterization

The surfaces of the tensile tested joint adherents were analysed to determine the failure type and the locus of failure. Various techniques, including; digital image processing, SEM and XPS were used for the failure surface analysis.

Expected outcome.

One commonly observed effect of moisture is the change in the failure locus for adhesive joint. Failure in high strength, unconditioned joint generally accord in adhesive joint, layer and known as cohesive failure. Depending on the moisture absorbed by the adhesive layer, the failure locus will move from adhesive layer to the adhesive-adherent interface and apparent and apparent interface failure may be observed. Type of failure will be observed for textured bonded joint at different interval of time and temperature.

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