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An Investigation of Friction Welding Heat Dissipation in Titanium Alloy and Stainless Steel

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ABSTRACT

The present examination of friction welded bonding properties are calculated in mechanical and metallurgical attained plasticity stages. Heat treatment studied the process of dissimilar metal joints of Stainless Steel and Titanium Alloy which was explored the parameter. In friction welding special alloy bonding strength was due to poor so directly we cannot join successfully. This alloy surface after joined with changes occurs in the surfaces. The melding temperature of Ti-6Al-4V is near 1600-1650º C but SS304L melding temperatures are like 1400-1450º C. The nearest same melding temperature joining is very difficult. So we added the aluminium interlayer to join the Ti-6Al-4V and SS304L.the rotation speed has recommended traveling 10 mm accelerating maximum rotating friction welding stages. Validating the experimental model was developed successfully. The joining parameters are identified as the minimum energy and minimum power consumption for constraints better quality of welding.

Keywords: Friction Welding, Tensile Strength, Microstructure Studies, Energy absorption, heat dissipation.

1. **Introduction**

Titanium and stainless steel alloys are mostly used in aerospace applications and biological applications of the best mechanical properties and more strength as compared to other dissimilar materials [1-4]. Titanium as nanoparticle is also incorporated in combustion process which contributes an enhanced thermal conductivity and better surface area-to-volume ratio and results in complete combustion [5-11]. It is having more corrosion resistance in the joining of dissimilar material properties [12]. Heat treatment process is very difficult in the field of friction welding joining dissimilar materials [13-14]. Ti-6Al-4V and SS304L considered as wieldable friction welding. The microstructure of high residual stresses and low thermal conductivity, high reactivity are good properties of dissimilar metals.

Two Ti-6Al-4V alloys are friction welded successfully in the field of microstructures and hardness characteristics of successfully investigated [13-15]. Various welding parameters are connected in the field of two different dissimilar materials in the field of friction welding process. The separate study has reported of friction welding effect on the tensile strength of Ti-6Al-4V and SS304L [16]. Tool parameters are considered to the deformation and controlling based on friction welding is a consideration. The mechanical processing becomes critical structures due to attracting rotational tool speed as consider with different levels of mixing and deformation occurs [17].

Fig.1. Titanium Ti-6Al-4V bar

Several attempts were taken to understand for experimental material flow characteristics in the friction welding process [16]. The preliminary study suggests that 60% of all type of aerospace structures may be manufactured using in friction welding process [17].

Limited industries are only minute fracturing the titanium alloys to manufacture in the field of aerospace applications [17]. The titanium and stainless steel models are shown in fig 1 and 2. Many industrial applications are using welding type of friction is getting more ability to inertia friction welding process is high.

2. Experimental Procedure

The experimental materials are Ti-6Al-4V and SS304L manufactured in round rod with 50 mm in length and 20 mm diameter was done successfully. The mechanical properties and chemical parameters are analyzed with the standard of room temperature. Box–Behnken parameter of design is considering maximum energy efficiency in an experimental process. The physical parameter constrains expensive constraints more ability to provide combination levels of the structures. The machining process is prepared by the sample bar diameter of 20 mm with the length of 50 mm as per standard size. Initially joint level 1 is connected the stainless steel and aluminum of the portion successfully and cut some of the extra portions in the face of aluminium side and another joint level of 2 is connected the titanium and aluminium. Removed the extra portions of aluminium faces successfully done. After connected the aluminium alloys to start the friction welding process of normal speed. Due to increased time and speed, more amount of aluminium came out the welding process. After welded materials, we understand the material characteristics successfully. Sample welded joints are dropped the standard height from the ground levels. The drop test results are given excellent bonding conditions are welded different parameter. Now that specimen was taken for advanced study. The higher composition was established to be investigated aluminium interlayer. The aluminium flashes are removed from the machining process and tested the microstructure and hardness results are successful. Tensile test results are showing more suitable results of hardened materials. Microhardness test was done in Vickers hardness parameters. The variation of the cracks is initially started from the middle line of the aluminium packages.

Fig.2. Stainless steel SS304L bar

2.1 Frictional Welding

Friction welding is a solid study state welding process which connecting two dissimilar or similar materials with increasing pressure. Normally one part is rotating with a certain speed of pressure and another one is relatively heat generated by friction between the two components of joining conditions. The welding processes may be affecting the joint properties through heat dissipation and heat generation. Friction welding process parameters were done and reducing interface hardness and increasing tensile properties interfacing surface parameters are done.

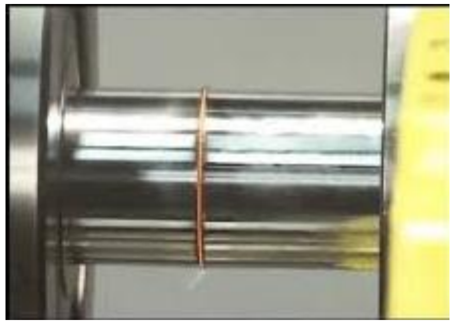

Fig.3. Friction welding process

Increasing speed ranges, as well as dissimilar materials, are producing melting point range as follows in the fig.4. Rotational speed has increased between time period and accelerations. Highest revolutions are occurring in the field of connecting different dissimilar joints as per the standards. Sometimes are constant speed has maintained.

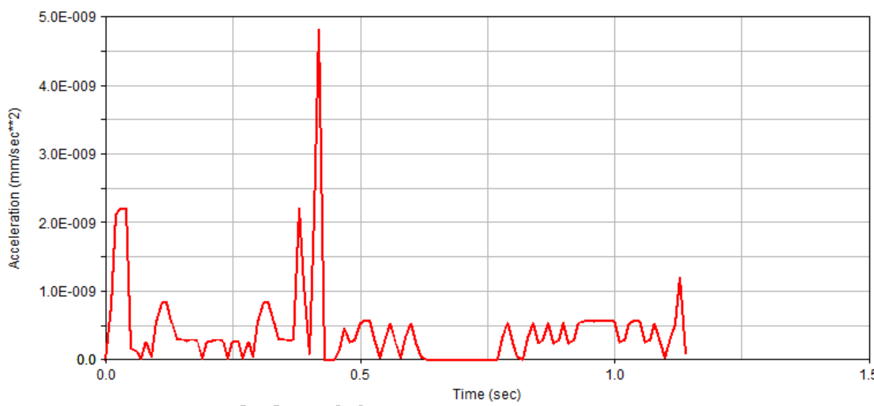

Fig.4 friction welding heat dissipation process

Forces are varying in the area of titanium and stainless steel per standard revolutions. The temperature was monitored with changing of forces acting in the field of friction welding heat dissipations. The most of forces are increasing the time constants. It was shown in fig 5.

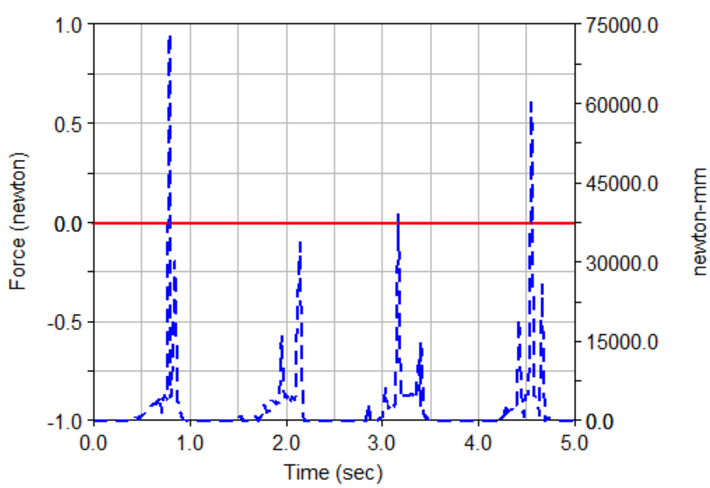

Fig.5 Connecting two dissimilar materials friction

2.2 Tensile test

Normally tensile test results are identified the metallurgical and mechanical characterizes of bonding properties. Tensile specimens are machined from the stir directions are forming ambient temperature. The tensile tests are usually conducted at room temperature. The yield strengths vary from 68% to 78%. The tensile results are shown in fig. 6.

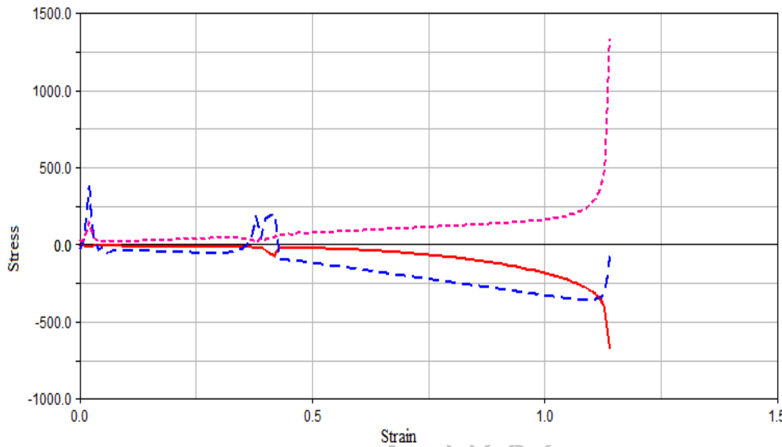

Fig.6. Tensile test characteristics of the welding process

These results are showing good agreement of microhardness and compression ranges. Tensile bars are starts from a crack in the line of near welded locations. The test samples were inserted into the UTM machine and calculated as per the test procedure which was conducted perfectly.

The test results are showing breaking welding areas of the steel is to find the velocity is shown in fig 7.

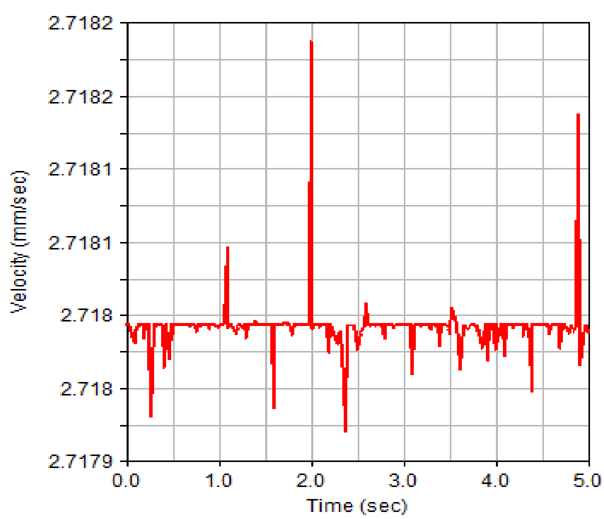

Fig. 7 Stainless steel tensile limits

2.4 Microstructural Studies

Ti alloy was broken and mixed with the stainless steel alloy. Titanium alloys rotational speeds are different as compared to stainless steel. Stainless steel rotating RPM is 700 and titanium rotational speed of RPM is 850. The SEM images are shown in fig.8. SEM statement analyses EDM was performed chemical composition weld interface is shown in fig.8.

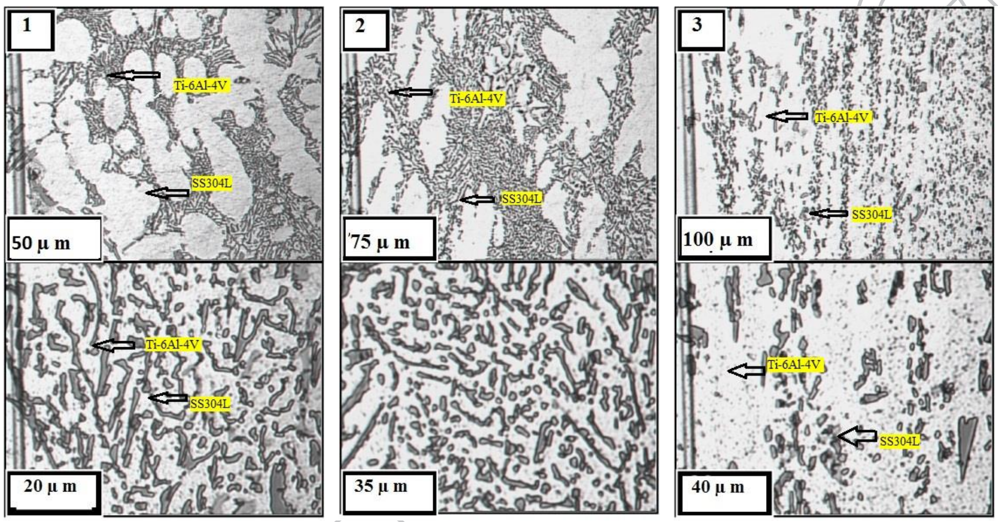

Fig.8 SEM test results

The samples are cleaned with magnesia, alumina powder of the surfaces with macro and micro surfaces were analyzed successfully. The stainless steel parameters are shown in the centre from away results are producing. Some strain connection bond is preferred interface zone varies according to plastic deformation in both alloys.

Table 1 welding speed calculations

Rotational speed N(rpm)	1500
Welding speed V (mm/s)	.3 ~1
Heating time t (s)	25

The microstructure of stainless steel intermetallic region has improved high strength bonding and low strength bonding was performed to the interface region.

4. Conclusion

A comparative study was understood successfully with the weld of the friction welding of Ti-6Al-4V and SS304L. From our experimental results are proved the different dissimilar materials like Ti-6Al-4V and SS304L we cannot joint directly. We added aluminium interlayer of successfully joining process which was done in this study. The martensite phase resulted in a brittle compound shown lower strength. Two dissimilar alloys joints directly it was absorbed poor joints. Mechanical and metallurgical formation it was shown good characteristics of the sample welded joints. This joint did not have 100% efficiency due to an increase in the tensile strength of different anisotropic properties. The increment of rotational speed passed with the distribution of internal temperature along the rotational direction. This study was successfully done in the occurrence of material flows and strain rates. The proof constant study is stable of the application process and phenomenon microstructure interface reducing in both elongation and tensile strength. High order fracture bond appears in the side of stainless steel portion appeared in this experiment.

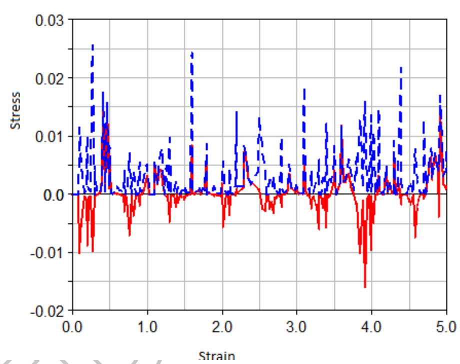

Fig.11 thermal flow process in two alloys

Thermal flow generations are extending applied pressure and temperature. The effective range of low friction welding microstructure modelling could be a help to find the different formations are shown in fig11.

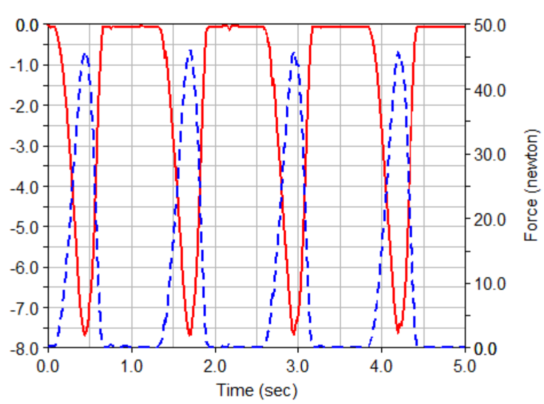

Fig 12 chemical composition of different materials

Mechanical surface properties under static loading conditions are essentially performed the original chemical compositions graph is shown in fig.12

Table 1 Results appeared in the tensile test

	Tensile strength (MPa)	Stress (MPa)	Elongation (%)	Fracture point
Joint	155	84	1.4	BM
Weld	158	83	4.7	TMAZ
SN	233	89	12.4	SN

The above results are appeared in the final test results for tensile and fracture points. In This study finally, we are considering the joint characteristics of titanium and welding parameters are considered to the effect of two dissimilar joint defects and adding aluminum coating with interacting the two dissimilar parameters are considered with the scope of welding techniques are appeared in the study state evaluations are successful.

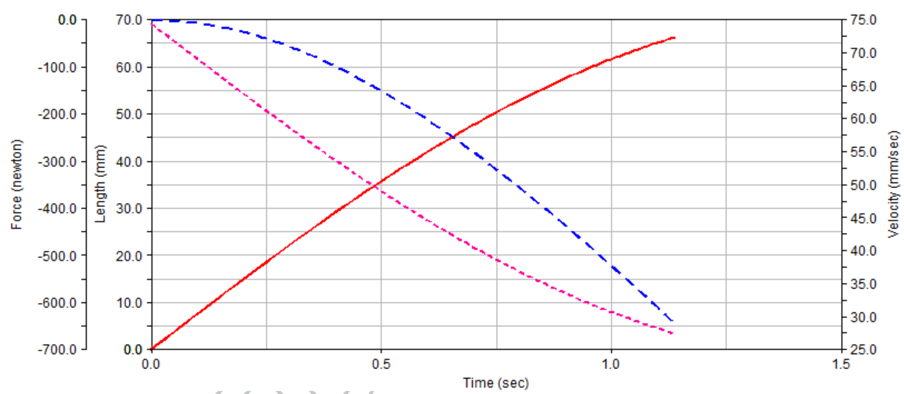

Fig.15 Force and velocity varying depend on time

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