RAISER INNOVATION AWARD FOR FRICTION WELDING 2011.

1. Candidate Resume/Curriculum Vitae

i.	Dr.P.Sathiya, Associate Professor	- Annexure I
ii.	Dr.S.Aravindan, Assistant Professor	- Annexure-II
iii.	Dr.A.Noorul Haq, Professor	- Annexure-III

2. A brief description of the research and development project:

Friction welding is a solid state process and it is best suited for joining similar and dissimilar materials. It circumvents the problems associated with the traditional fusion joining processes. Because of the superior properties, it is pertinent to use stainless steels in various automotive, aerospace, nuclear, chemical and cryogenic applications.

This investigation emphasizes on joints of industrially important stainless steels such as austenitic and ferritic stainless steels. Recently, super austenitic stainless steel (SASS) joints are also produced by this friction welding process. It is difficult to produce defect free welds of stainless steel joints by fusion methods. Hot cracking, chromium carbide precipitation in the grain boundary, grain coarsening, occurrence of inter granular corrosion, grain boundary precipitation in the heat affected zone (HAZ) like σ and R and formation of the intermetallic phases, carbides in the weld region while in service are the major pitfalls in fusion welding. Almost no published literature is available on friction welding of super austenitic stainless steel.

A continuous drive friction welding machine (KUKA) is used to process similar joints. Cylindrical specimens of austenitic stainless steel and ferritic stainless steel of similar composition and shape (equal diameter and length) were used in this study. The processed joints (Figure 1) were tested through uni axial tension test, impact test and hardness test. The friction processed joints exhibited comparable strength with the base material and joint strength decreased with an increase in the friction time. The material shear flow (Figure 2) and dimples at the fractured surface confirms the ductile mode of failure of joints during tensile testing. The refinement of grains at the weldment increases the weld toughness in friction joints of ferritic stainless steel weldments. The increase in hardness at the plasticized zone is attributed to the finer grain size of plasticized zone. The average increase of hardness at the weld zone compared to the parent material is of 54.54%. The refinement of grains has occurred at weld region by the combined effect of thermal and mechanical stresses. Plasticized zone (PZ) exhibits finer grain structure compared to the partly deformed zone (PDZ) and undeformed zone (UZ). Nearby zone having coarser grains (Figure3) is called as partly deformed zone. Evolutionary computational algorithms are used to optimize the process parameters to achieve excellent joints. Joints processed by this method exhibited better properties compared to the fusion processed joints.

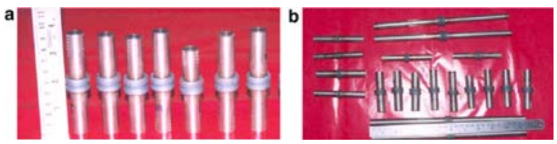

Figure 1 Friction processed joints

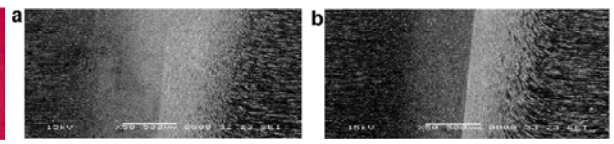

Figure 2 SEM microstructure

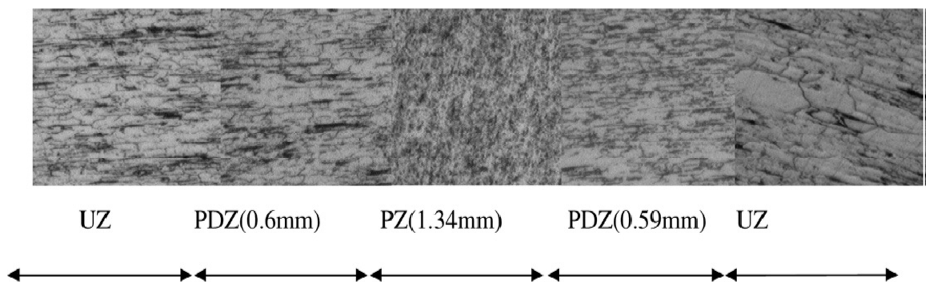

Figure 3 Cross section microstructure morphology (300X).

3. A comprehensive publishable description of the project, this can also be an existing or submitted publication

The friction welding trials were conducted on AISI 304 stainless steel, and the metallurgical and mechanical properties of the joints were investigated. The burn-off tends to increase with increasing friction time. Friction time increased the width of re crystallization region but partly deformed region decreased. The joint tensile strength decreased with an increase in the friction time. Both tensile and impact fracture surfaces appears in ductile mode, without dimples. The increase in hardness at the joint zone is attributed to the heating temperature of material at the weld region.

Similar joints of AISI 430 ferritic stainless steel were processed. The processed joints exhibited better mechanical and metallurgical characteristics, than the fusion joints. Because of the solid state bonding technique, the problems associated with fusion joining are minimized in the case of friction welding. The friction joints exhibited 95.52% of parent's materials tensile strength. The toughness of the friction welded ferritic stainless steel is comparatively higher than fusion processed joints due to the refinement of grain size at the weld zone.

Optimization of welding parameters and scientific approach to get the high quality joint is the very much need of today's welding scenario. The relationship between the input parameters such as heating pressure, heating time, upsetting pressure and upsetting time with the output parameters like tensile strength and metal loss is modeled through artificial neural network (ANN). The developed ANN model is suitably integrated with optimization algorithms. To optimize the welding parameters, genetic algorithm (GA), simulated annealing (SA) and particle swarm algorithm (PSO) techniques were employed. Among the three algorithms GA outperforms well for this friction welding process. The optimized welding parameters of GA, the friction welding joints were processed.

Joints exhibit higher quality. The good agreement between the theoretically predicted (GA) and experimentally obtained tensile strength and metal loss confirms the applicability of these evolutionary computational techniques for optimization of process parameters in the welding process.