

Effect of Welding Current and Welding Time for Micro Resistance Spot

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Effect of Welding Current and Welding Time for Micro Resistance Spot Welding on Dissimilar Thin Thickness Materials of Al 1100 and KS 5 Spring Steel

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Abstract. In the dissimilar materials and dissimilar thin thickness sheets joining, welding current and welding time parameters of resistance spot welding (RSW) effect weld ability. RSW used for joining thin plate less than 1000 μm is called micro-resistance spot welding (μRSW). The objective of this article is to study the effect of welding current and welding time to the joining dissimilar thin thickness materials and the microstructure of a weld joint. The thickness of Al 1100 is 400 μm , and KS 5 Spring Steel is 200 μm . Welding parameters are Cycle Time 0.5, 1, 1.5, Welding Current 1kA and 2 kA, and holding time 10 second. Welding current 1kA, Cycle time of 0.5 produce maximum shear load of 227.4 N and fracture area of 6.644 mm^2 . Welding current 2 kA, cycle time of 1.5 affect maximum load of 222.7 N and fracture area of 10.559 mm^2 . Welding parameters lead to the majority fracture on aluminum material. The welding current and cycle time do not significantly affect maximum shear load and fracture area.

Introduction

Resistance Spot Welding (RSW) is still commonly used in automotive industry because the welding method is most economic, reliable and simple processing [1]. Friction Stir Welding (FSW) process to materials with thickness less than 1000 μm , it is called micro-friction stir welding (μFSW). μFSW can be applied at thin walled structures, electrical, electronic and micro-mechanical assemblies [2,3]. Resistance spot welding uses thin plat less than 1000 μm , so it is called micro-resistance spot welding (μRSW).

The welding process of dissimilar materials and different thickness has been researched. Some welding technologies applied to dissimilar materials were studied. SMAW process of dissimilar material non-ferrous metals was studied by Belinga Mvola [4]. Characterization of Friction Stir Spot Welding to joint dissimilar material aluminum alloy was studied by Joaquín M. Piccini [5]. This paper studies the joint of different thin sheet of dissimilar material by Resistance Spot Welding (RSW). The RSW to joint dissimilar materials on difference thin plat Al-Steel is not yet enough studied. There are many challenges in joining Al alloys to steels because of the very different properties of the both metals. The RSW process of thin dissimilar has many problems because on the thin sheets leads to hole or cavity. This paper gives important contribution to micro welding process which applied small products or structures. This paper also studies the effect of the welding current and welding time parameters of RSW to weld ability.



Materials and Experiment Procedure

Materials

Materials used in this paper were aluminum AA1100 and steel KS 5 spring sheets. The thickness of Al 1100 used in this paper is 400 μm , and the thickness of KS 5 Spring Steel is 200 μm . According to a standard dimension of ANSI/AWS [6], when the thickness of materials used less than 800 μm , these material sheets were cut at the length 76 μm , and wide 19 μm (fig. 1 and fig.2).



Fig. 1 – The specimen of KS 5 steel

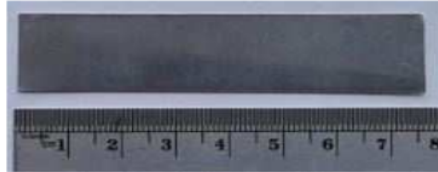


Fig. 2 – The specimen of Al 1100

Chemical composition and mechanical properties of the specimen KS 5 steel and Al 1100 are shown in Table 1 and Table 2.

Table 1. Mechanical properties and chemical composition of KS 5 Steel String [7]

Tensile properties	Mpa	Chemical composition %			
Tensile Strength	703	V 14.0	Cr 2.5	Sn 2.5	Al 2.5

Table 2. Mechanical properties and chemical composition of Al 1100

Tensile properties	Mpa	Chemical composition %					
Tensile Strength	89.6	Al 99	Be 0.0008	Cu 0.20	Mn 0.050	Si+Fe 0.95	Zn 0.10

The welding machine is used by medium and heavy industry, commonly automotive or assembly industries. This machine can weld the maximum thickness 2.5 mm of plate, the voltage 220 or 380 V and 1 or 2 phase. Tensile test machine can be used a maximum load less than 10kN.

Experimental Procedure

The specimens were joined by RSW machine which use 220 V 1 phase, Parameters welding current of 1 kA and 2 kA, welding time 0.5 cycle time (ct), 1 ct, and 1.5 ct, where the holding time electrode and force are kept constant. Welding parameter is shown in the Table 3. The example of specimen Al 1100/KS 5 steel that was joined by welding parameter of holding time of 10 sec, 1.5 ct, and welding current 2 kA is shown in Fig. 4.

Table 3. Welding Parameter

Welding current (kA)	Holding time (S)	Cycle time
1	10	0.5
1	10	1
1	10	1.5
2	10	0.5
2	10	1
2	10	1.5



Figure 4. Holding time (T) 10 second, Cycle time (CT) 1.5 and Current (I) 2 kA

In order to test the maximum load, the specimens were tested for each parameter using 5 specimens. Mean of maximum shear load of 5 specimens are shown in a table and a maximum shear load – strain graphic. This paper used macro analysis to explain the macro structure properties of both materials and on weld joint zone.

Result and Discussion

Result of shear load test was calculated and the means of magnitude is shown in the table 4. A shear load and a strain graphic of the shear test were recorded by computer and are shown in the Fig 5 and the table 4.

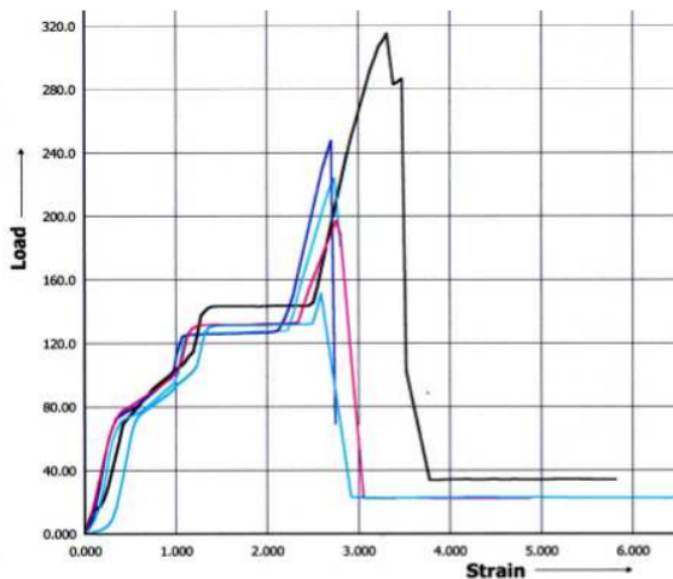


Figure 5. Load and strain graphic of the welding parameters current of 1 kA, cycle time of 1.5 for 3 specimens and current of 2 kA, cycle time of 1.5 for 2 specimens.

Table 4. Result of the maximum shear load

No. of Specimen	Welding Current (kA)	Cycle Time	Holding Time (second)	Max Shear Load (N)
1	1	0.5	10	227.4
2	1	1	10	213.6
3	1	1.5	10	187.9
4	2	0.5	10	216.6
5	2	1	10	127.6
6	2	1.5	10	222.7

Specimens tensile shear tested and the fracture (cavity) of the tested impact were measured by the digital microscope software. Some of parameters fractured on both materials, one of specimens which the both material led to hole were shown in fig 6.a and 6.b.



Figure 6.a. Al 1100 T 10/CT 0.5 / I 2 kA



Figure 6.b. KS 5 Steel 10/CT 0.5 / I 2 kA

The result of fracture area of weld joint is presented in the table 5.

Table 5. The fracture area of material

No	Welding Parameter				Fracture Condition		Fracture Size (mm ²)	
	Specimen Code	Welding Current	Cycle Time	Holding Time	Al 1100	KS 5	Al 1100	KS 5
1	1a	1 kA	0.5	10 second	Fracture		6.644	
2	1b	1 kA	0.5	10 second		Fracture		5.823
3	2a	2 kA	0.5	10 second	Fracture		13.187	
4	2b	2 kA	0.5	10 second	Fracture		9.796	
5	2c	2 kA	0.5	10 second	Fracture		13.393	
6	2c	2 kA	0.5	10 second		Fracture		6.089
7	1a	1 kA	1	10 second	Fracture		9.662	
8	1b	1 kA	1	10 second	Fracture		6.062	
9	1c	1 kA	1	10 second	Fracture		11.219	
10	1c	1 kA	1	10 second		Fracture		10.559
11	2a	I 2 kA	1	10 second	Fracture		12.220	
12	2b	I 2 kA	1	10 second	Fracture		9.318	
13	1a	1 kA	1.5	10 second	Fracture		10.882	
14	1b	1 kA	1.5	10 second	Fracture		11.878	
15	1b	1 kA	1.5	10 second		Fracture		9.929
16	1c	1 kA	1.5	10 second	Fracture		11.880	
17	1c	1 kA	1.5	10 second		Fracture		8.727
18	2a	2 kA	1.5	10 second	Fracture		10.559	
19	2b	2 kA	1.5	10 second	Fracture		10.559	

Discussion

Fig.5. shows that the black line near 320N maximum shear load, which means that one of some specimen which was welded by welding current of 1 kA, welding time of 1.5, and holding time of 10 second can produce the maximum shear load of 310 N. Table 3 shows the results of the maximum shear load and welding parameters presents that the welding current of 1 kA, cycle time

of 0.5, and maximum shear load of 227.4 N, welding current of 2 kA, cycle time of 1.5, maximum shear load of 222.7 N. Table 5 shows that the fracture occurs not only on Al 1100 specimen but also on KS 5 specimen.

Summary

The welding process of the dissimilar thin plates joining uses a micro-resistance spot welding (μ RSW). In this study, by welding parameter of Welding Current of 1 kA, Welding Time 0.5CT produces the maximum load of 227.4N and fracture area only 6.644mm². The welding current of 2 kA, welding time of 1.5CT produce the maximum shear load of 222.7 N and fracture area of 10.559 mm². These welding parameters produce many fracture on aluminum materials. The welding current and cycle time do not significantly affect maximum load and fracture area. In the welding process of dissimilar materials Al 1100 and KS 5 steel is complex parameters because of the different properties.

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