ANNALS of the ORADEA UNIVERSITY.

Fascicle of Management and Technological Engineering

RESISTANCE SPOT WELDING OF METALLIC COMPOSITE MATERIALS WITH STAINLESS STEEL FIBRES REINFORCED ALUMINIUM ALLOY MATRIX

Stelian NEGOITESCU, Eduard BERGER, Remus BELU
Politehnica University Timisoara, eberger@mec.utt.ro, rbelu@mec.utt.ro

ABSTRACT

One of the welding procedures for the metallic composite materials (MCM), to be used is the resistance spot welding (RSW). By this process, a fact that limits the possibility to appear and develop brittle structures at the reinforcing fibre – matrix level. When using the RSW, the MCM are suffering important deformations in the joining place, which can lead to the destruction of the reinforcing fibres.

The entire technological and testing programme has been elaborated within POLITEHNICA University Timisoara.

1. GENERAL PROBLEMS

One of the welding procedures for the metallic composite materials (MCM), to be used is the resistance spot welding (RSW). By this process, a fact that limits the possibility to appear and develop brittle structures at the reinforcing fibre – matrix level. When using the RSW, the MCM are suffering important deformations in the joining place, which can lead to the destruction of the reinforcing fibres [1÷10].

2. THE OVERLAPPING JOINING OF A METALLIC COMPOSITE MATERIAL USING THE RESISTANCE SPOT WELDING

2.1. METALLIC COMPOSITE MATERIALS FOR RESISTANCE SPOT WELDING

Tests to elaborate the welding technology were made in the Welding Equipment and Technology Department of the Faculty of Mechanical Engineering within the POLITEHNICA University Timisoara, the Resistance Welding Laboratory [8].

Figure 2.1 presents the MCM specimens available for experimental research using the resistance spot welding.

Figure 2.2 presents the stainless steel reinforcing, copper plated to assure a good adherence to the matrix material (aluminium alloy), and figure 2.3 presents the MCM worked to see the reinforcement. Figure 2.4 presents a 0.5 mm thick MCM, and figure 2.5 the section through the MCM.

2.2. CLEANING SURFACES BEFORE WELDING

Before welding the specimens were worked, following the operational succession indicated in table 1.1.

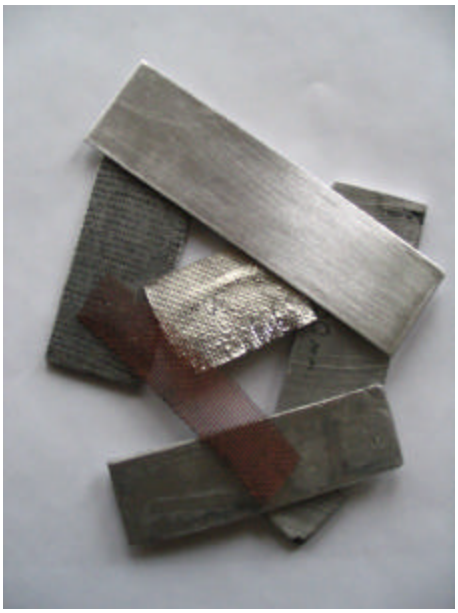

Figure 2.1. Base metals (MCM)

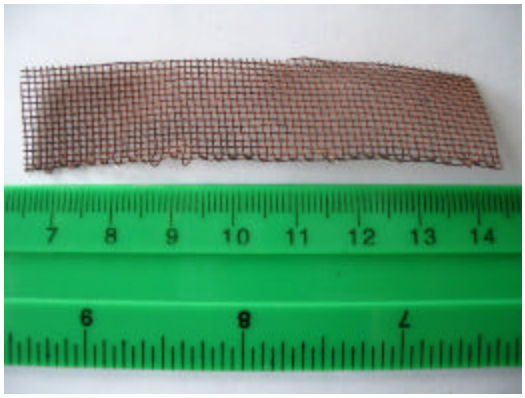

Figure 2.2. The MCM reinforcement

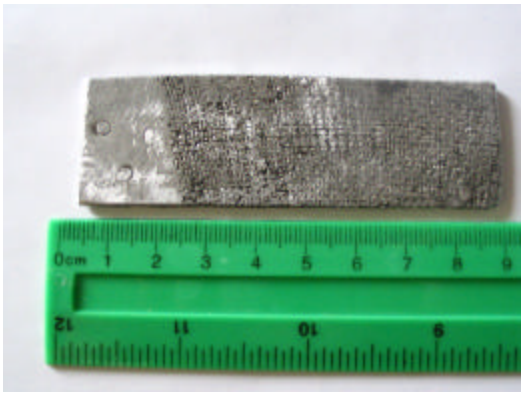

Figure 2.3. The MCM worked to see the fibres, 2.6 mm thick

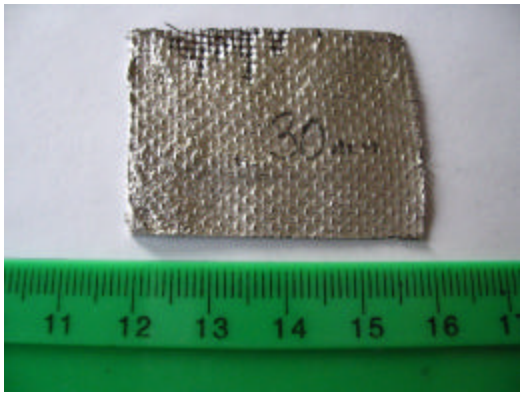

Figure 2.4. The 0.5 mm thick MCM

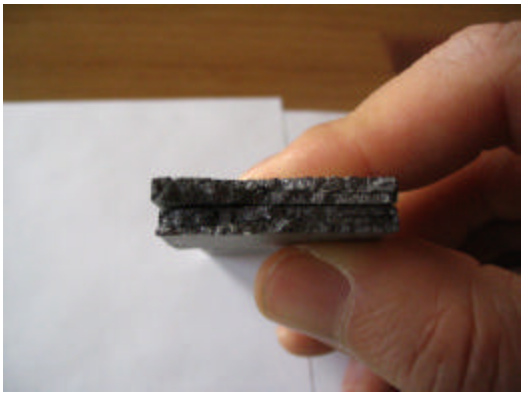

Figure 2.5. Section in MCM

Table 2.1. The MCM working before welding

Operation	Aim	Details
Abrasion	Removing the plating, deep scratches, defect material	600 abrasive paper
Degreasing	Removing volume organic impurities	acetone
Alkaline cleaning	Removing the oxide layers formed during lamination or heat treatment	Solution (5 min, 60°C): 0.5%NaOH; 0.5%Sodium gluconate
Rinsing, washing	Removing the cleaning and degreasing solutions	Water jet (5min. 60°C)
Pickling	Creation an oxides film	Solution (30min, 60°C): 2.5wt% Na_2-Cr_2O_7-$2H_2O$; 24.3wt% H_2SO_4
Rinsing, washing	Removing the pickling solutions	Water jet (5min. 60°C)
Phosphoric anodization Rinsing, washing	Creation of a micro coarse layer Removing the anodization solutions	Concentration solution 10-85%phosphorous acide. Keeping to 10 V for 3 min. Keeping for 25 min at 20-25°C Water jet (5min.)
Drying	Removing the humidity from the superficial layer	In vacuum chamber 30 min. at 60°C

2.3. RESISTANCE SPOT WELDING

In order to elaborate the welding technologies a specialized equipment for welding aluminium and its alloys was used. It belongs to the Welding Equipment and Technology Department and is a 6000 series TECNA. Within the technological testing according to the cyclogram in figure 2.6 9 welded specimens were made with the technological elements detailed in table 2.2.

Table 2.2. Technological welding data of MCM

Speci-men no.	Thickness s (mm)	Squeeze t_1 0-99 (p)	Slope t_3 0-50 (p)	Heat t_4 1-99 (p)	Cool t_5 0-99 (p)	Post weld t_6 0-99 (p)	Hold t_7 1-99 (p)	Forge delay t_9 0-99 (p)	I_s %	I_s (20-99) xI_M kA	F_s bar	F_s daN	F_f bar	F_f daN	period	I_s div	I_s kA	U_{1r} div	U_{1r} V
1	**2.5-2.5**	**70**	**3**	**6**	**0**	**0**	**40**	**9**	**80**	**40.7**	**3.25**	**400**	**5**	**630**	1	68	39.9	58	367.3
															2	69	40.5	56	354.6
															3	70	41.1	55	348.3
															4	70	41.1	55	348.3
															5	70	41.1	55	348.3
															6	70	41.1	55	348.3
2	**3.0-3.0**	**70**	**3**	**8**	**0**	**0**	**40**	**11**	**95**	**44.8**	**3.25**	**400**	**5**	**630**	1	74	43.4	57	360.9
															2	75	44.0	55	348.3
															3	76	44.6	55	348.3
															4	76	44.6	55	348.3
															5	76	44.6	55	348.3
															6	76	44.6	55	348.3
															7	77	45.2	55	348.3
															8	78	46.0	55	348.3
3	**3.0-3.0**	**70**	**3**	**8**	**0**	**0**	**40**	**11**	**95**	**45.5**	**3.25**	**400**	**5**	**630**	1	74	43.4	56	354.6
															2	75	44.0	55	348.3
															3	76	44.6	54	342
															4	77	45.2	54	342
															5	78	46.0	54	342
															6	78	46.0	54	342
															7	78	46.0	54	342
															8	79	46.3	54	342
4	**3.0-3.0**	**70**	**3**	**8**	**0**	**0**	**40**	**11**	**80**	**41.4**	**3.25**	**400**	**5**	**630**	1	64	37.5	58	367.3
															2	66	38.7	54	342
															3	68	39.9	55	348.3
															4	69	40.5	55	348.3
															5	70	41.1	55	348.3
															6	70	41.1	55	348.3
															7	71	41.6	55	348.3
															8	72	42.2	55	348.3
5	**2.5-2.5**	**70**	**3**	**7**	**0**	**0**	**40**	**10**	**70**	**38.1**	**4.1**	**500**	**5**	**630**	1	60	35.1	58	367.3
															2	62	36.3	56	354.6
															3	64	37.5	56	354.6
															4	65	38.0	56	354.6
															5	65	38.0	56	354.6
															6	66	38.7	56	354.6
															7	66	38.7	56	354.6
6+7	**2.5-3.0**	**70**	**3**	**7**	**0**	**0**	**40**	**10**	**65**	**33.0**	**4.1**	**500**	**4.9**	**615**	1	56	32.8	58	367.3
															2	58	34.0	57	360.9
															3	60	35.2	56	354.6
															4	61	36.0	56	354.6
															5	61	36.0	56	354.6
															6	61	36.0	56	354.6
															7	62	36.4	56	354.6
8	**2.5-3.0**	**70**	**3**	**7**	**0**	**0**	**40**	**10**	**75**	**38.2**	**4.1**	**500**	**4.9**	**615**	1	63	36.9	58	367.3
															2	65	38.1	56	354.6
															3	67	39.3	56	354.6
															4	69	40.5	56	354.6
															5	70	41.1	56	354.6
															6	70	41.1	56	354.6
															7	70	41.1	55	354.6
9	**1.0-0.5**	**70**	**1**	**3**	**0**	**0**	**40**	**4**	**50**	**26.6**	**1.8**	**220**	**2.7**	**330**	1	43	25.2	60	380
															2	45	26.4	58	367.3
															3	46	27.0	58	367.3

Obs. The electrode diameter = 19 mm
The tip electrode ray = 150 mm

Figure 2.6 presents the TECNA resistance spot welding equipment [6].

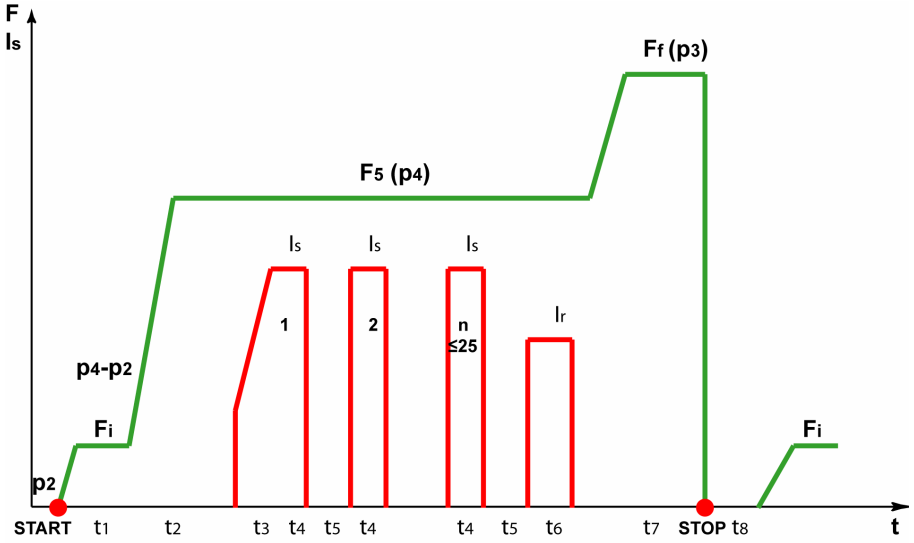

Figure 2.6 The cyclogram of the 6100 series TECNA resistance spot welding equipment

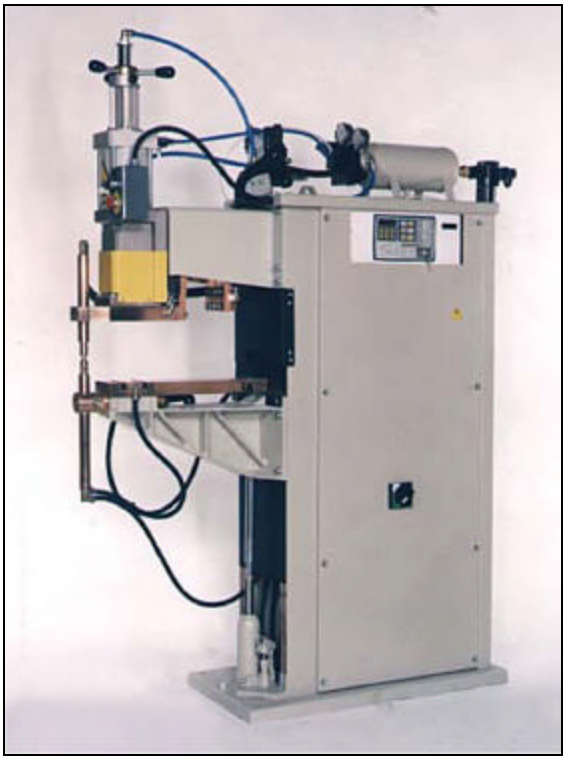

Figure 2.7. The TECNA resistance spot welding equipment

3. RESULTS OF THE EXPERIMENTAL PROGRAMME

The MCM samples welded by the RSW were subjected to a complex testing programme in the RENAR accredited Testing Laboratory within CIDUCOS of the POLITEHNICA University Timisoara.

These were found to be corresponding from the mechanical characteristic point of view; the metallographic examinations made on micro and macro specimens confirmed the quality of the welds obtained in this way.

4. CONCLUSIONS

4.1. The entire technological and testing programme has been elaborated within POLITEHNICA University Timisoara.

4.2. Starting from the differential values, given by the technical literature, the optimum technological parameters were obtained.

4.3. The following technological versions could lead to desired mechanical and exploitation characteristics.

4.4. The research work will go on and more MCM will be tested, with different volume participation, various thickness, elaborated by different technologies and the results will be communicated .

BIBLIOGRAPHY

[1]. Dragulescu, D. si Popescu, M.: Materiale compozite metalice – Prezent cu perspective, Editura Orizonturi Universitare – Timisoara, 1999

[2]. Howard, C.: Modern Welding Technology, 5th Ed. ASM, 1994

[3]. Perta, Gh.: Tehnologii de sudare prin presiune, litografie UTT, 1993

[4]. Popescu, M.: Îmbinarea materialelor avansate – Materiale compozite, Editura Eurostampa – Timisoara, 2002

[5]. William, L., Galvery Jr., Marlow, F: Welding Essentials: Questions & Answers, Welding Handbook, 1997

[6]. XXX : http://www.tecna.net

[7]. XXX : http://wwwweldtechnology.com

[8]. XXX : http://www.ewi.org/technologies/resistance/resistance.asp

[9]. XXX : Applications of aluminium matrix composites [J], Key Engineering Materials, 1995, 1:3

[10]. XXX : Welding Handbook, Vol 3 [M], American Welding Society, 8th Edition, Miami, 1996