HIGH SPEED FILMING OF AC AND MF RSW: A COMPARISON

Louriel Oliveira Vilarinho[1], Jose Enrique Vargas[2], Marco Antonio Wolff[1], Sadek Absi Alfaro[2]
[1] Federal University of Uberlandia
Laboratory for Welding Process Development (Laprosolda)
[2] University of Brasilia - Graco
vilarinho@mecanica.ufu.br

1. INTRODUCTION

The Resistance Spot Welding (RSW) is one of the most employed manufacturing processes in the automotive industry. The introduction of galvanized steel has brought some complications for the welding process quality what demanded new research lines. The scientific literature has focused on the analysis, monitoring and improvement of the mechanisms for the weld lens formation. Thus it is aimed to study the mechanism of the weld lens formation both in alternated (AC) and continuous medium-frequency (MF) current by using high-speed visualization and, differently from other authors, keeping the same level of energy and synchronize with the electrical signals.

2. EXPERIMENTAL PROCEDURE

The experimental rig is composed by a 75 kVA transformer and a controller used to supply water-cooled electrodes with pneumatic pressure from 87 to 261 kgf. The lens visualization was carried out by using a digital high-speed camera synchronized to the electrical signals. The electrodes are truncated in a 3 mm of length and placed parallel to the sheet. This requires that two criteria must be fulfilled: same energy ($I_2 = I_1/\sqrt{2}$) and same pressure levels ($F_2 = F_1/2$). The metal sheets are galvanized ones (hot-immersion technique) at three different configurations of thickness (2.0-2.0 mm; 2.0-1.2 mm and 1.2-1.2 mm).

3. RESULTS AND DISCUSSION

In the synchronized images (an example is shown in Figure 1), liquid drops can be observed forming on the surfaces of the upper sheet. It indicates that the zinc coating started to burn out. In the 10th welding cycle, the number of droplets is high in the area between the two sheets (large volume of zinc coating) and they become to be expelled (the same for MF welding). Also, the Joule heating starts to turn the sheet reddish and to form the lens. In the 16th cycle, there is no longer coating on the sheet surface and the metal has already started melting. The heat transfer (generation and sinking) between two welding cycles is characterized by the 21st cycle. Although it is small, the hot areas (red area) in these two images are not the same (by digital image processing this aspect can be better visualized and enhanced). After the current pulse the area is larger than after the non-active current time. This indicates that the weld pool pulses accordingly to the cycle pulses. This cannot be visualized in the MF welding. After that, a small indentation can also be seen. At the end of the 30th cycle, the lens reaches its maximum diameter and it solidifies after 207 ms that the current stops. Thus, if the electrode force were taken before it, the lens is still hot and defects would appear. As a further work, this solidification time can be modeled (analytically or numerically) and the results can be checked by using the present experimental work.

4. CONCLUSION

It is possible to concluded that the lens size varies accordingly to the current oscillation (in this case 60 Hz); the higher the rms current the longer the solidification time of the lens is required; the zinc coating starts to burn out by the first cycle for rms currents above 3 kA; around the 16th cycle the coating no longer exists for rms currents above 3 kA; at the 10th welding cycle the lens formation starts to be observed by a reddish area for rms currents above 3 kA; for rms currents below 2 kA, no lens was observed.

Keywords: Resistance Spot Welding, Nugget Formation, High-Speed Filming.

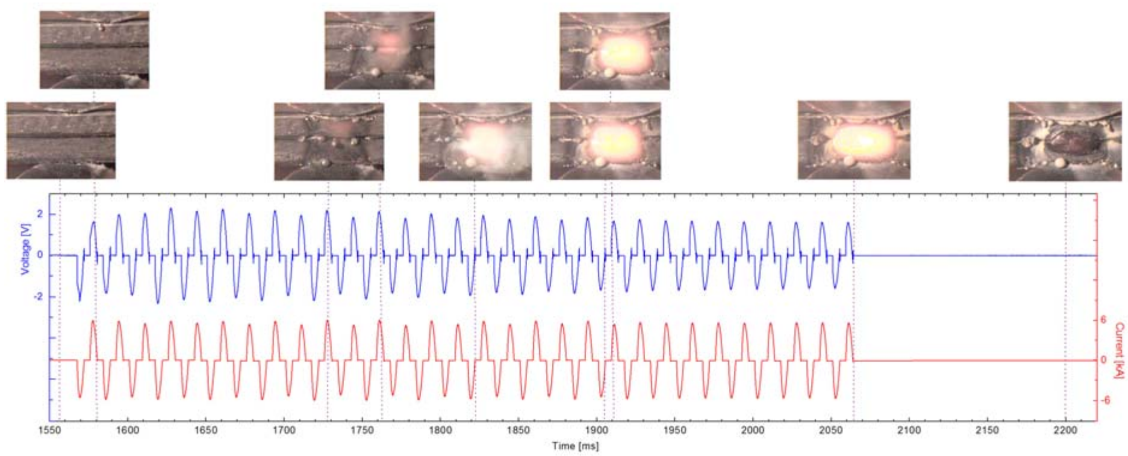

Figure 1. Example of the lens formation for a RSW process.