Research and Development of Modern Variants of Classical Arc Welding Technologies with High-Speed Videography with Laser Illumination

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Over the last years a profusion of new versions of arc welding processes has overwhelmed the international welding scenario in the industry and academia. Innovations have been made possible not only by means of electronics and software developments, but also through new concepts in mechanical design and mechanisms.

With respect to the TIG process, one example is Dynamic Feed (Wire Oscillation). Low productivity is often a disadvantage attributed to conventional TIG, when compared to other arc welding processes. In order to manage this drawback, as well to better deal with hard wetting materials (Ni-Cr alloys for example), a forward and backward wire oscillation movement has been implemented in TIG systems and it finds good acceptability in the industry as well as great interest within the scientific community. A further benefit of reducing porosity may also be expected from the technique. For the study and development of such techniques, high-speed filming has been a powerful tool for observation and stability evaluation of the metal fusion and transfer, arc behavior and weld pool behavior. Main objectives are scientific investigations on parameters influence over the resulting physical phenomena and development of parameterization for different welding conditions (position of wire feeding, torch geometry, wire dynamics).

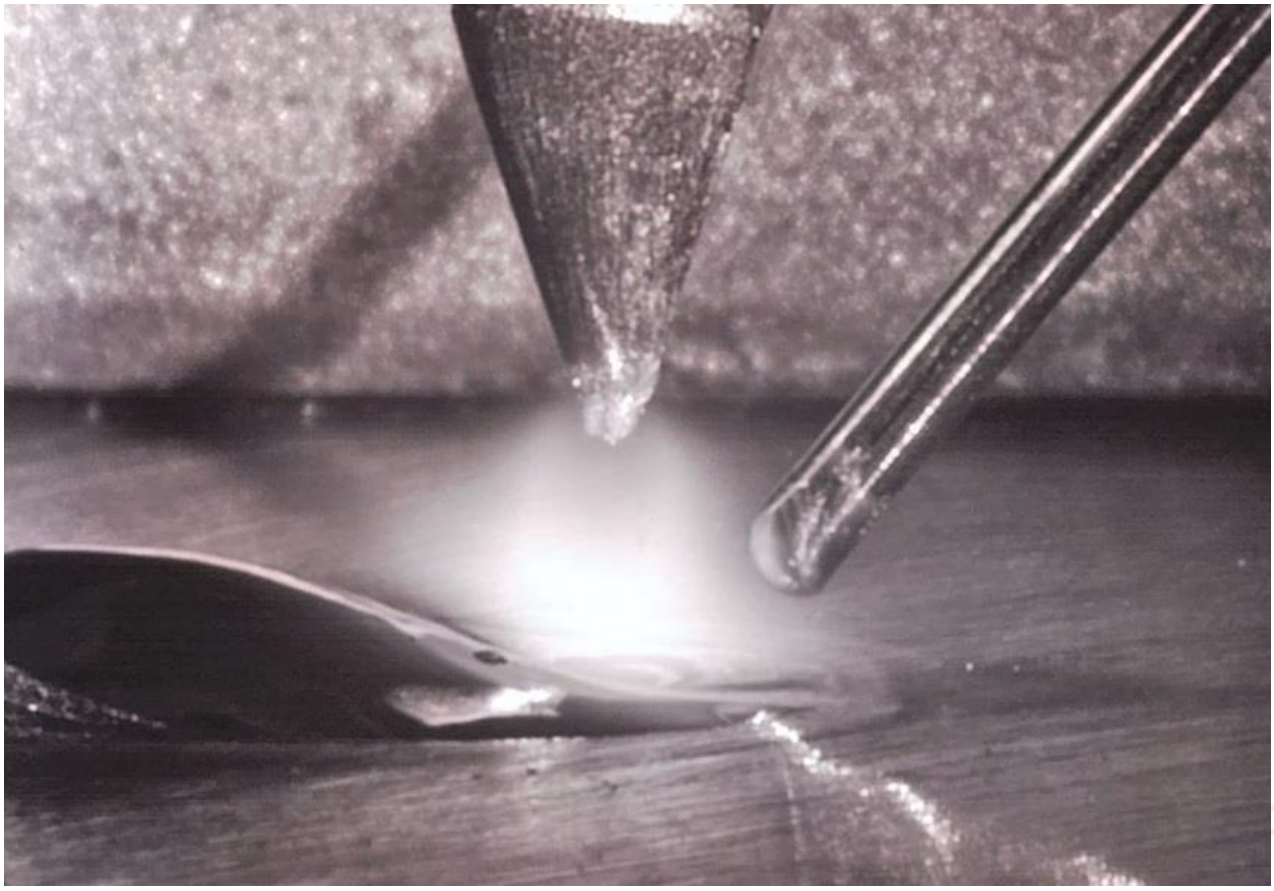

Figure 1: Dynamic Feed TIG Welding imaged at 1.000 fps

With respect to MIG/MAG welding, new technologies aim at developing adaptive control methods, innovative current waveforms and mechanization techniques in order to improve arc stability, metal transfer regularity, process reliability and expansion of the application range. Here, examples are the rotary arc and the pulsed arc mode, which are promising in achieving outstanding results for cladding and thick walled narrow gap joints. In these cases, high-speed filming is applied for metal transfer phenomena observation, arc movement patterns and respective influences over the weld pool, arc geometry and generation of the weld bead. Also, high-speed filming has been being applied to evaluation of consumables and peripherals (like wire-electrodes, contact tips and wire feeders).

Figure 2: Rotary Arc Pulsed MIG/MAG Welding imaged at 5.000 fps

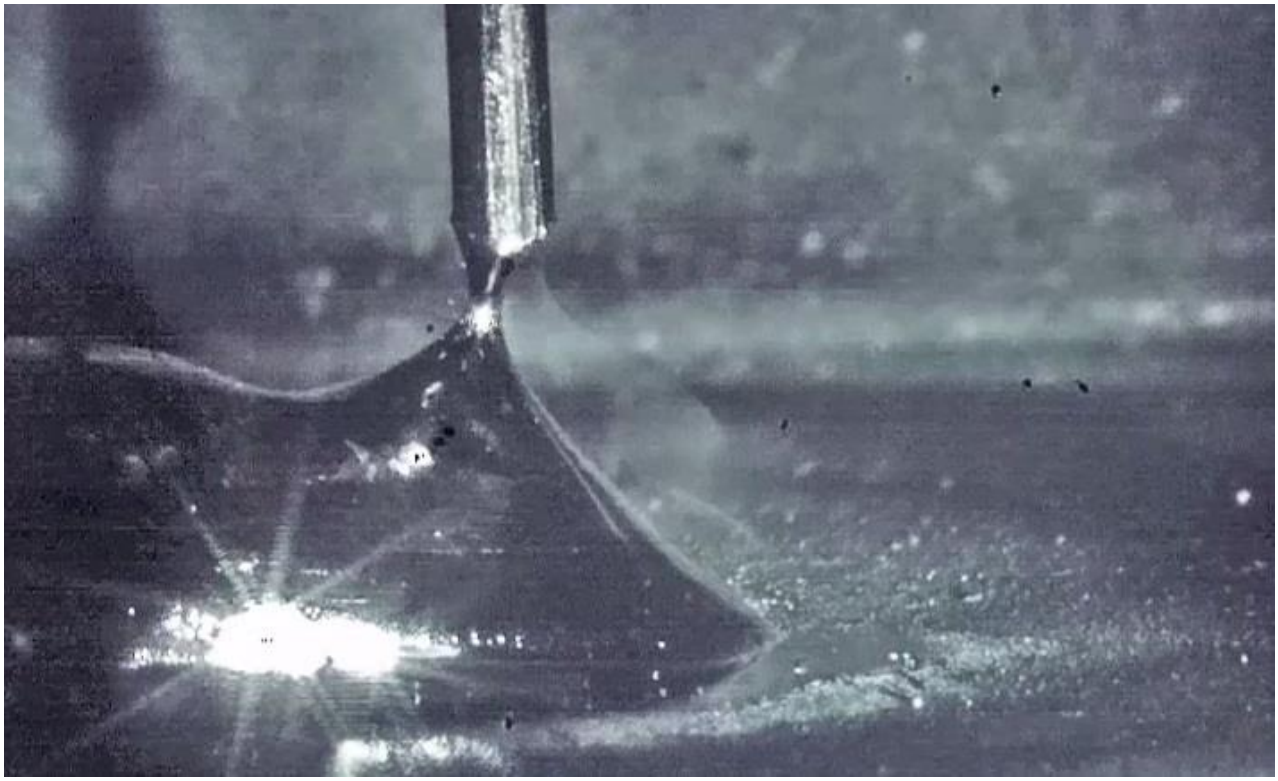

Figure 3: MIG/MAG Welding with forward/backward movement of the wire electrode imaged at 4.166 fps

For the images shown above a CMOS, 1.0 megapixel array size color camera was applied with 105mm and 180mm macro lenses. Acquisition rates were adjusted in synchronization with electric welding data monitoring via a data acquisition system.

In the scope of these investigations and developments, CAVILUX HF has been intensively applied. The laser illumination system allows us to finely adjust the arc intensity of the high-speed images produced, thus enabling the selection and isolation of specific welding process features (wire, arc, droplet, pool, etc.) which are goal sensitively, specifically meant to be monitored, analyzed and investigated.

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