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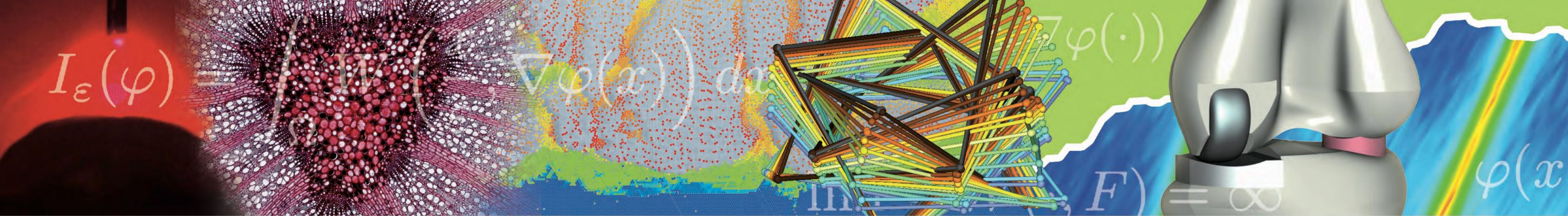
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Experimental study of metal transfer in CMT welding

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Introduction

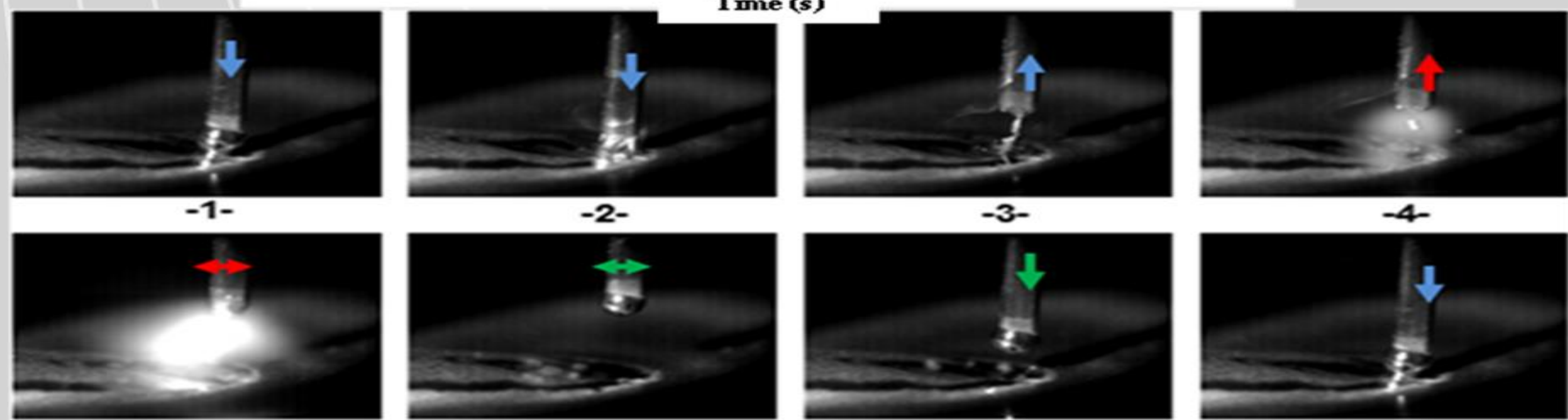
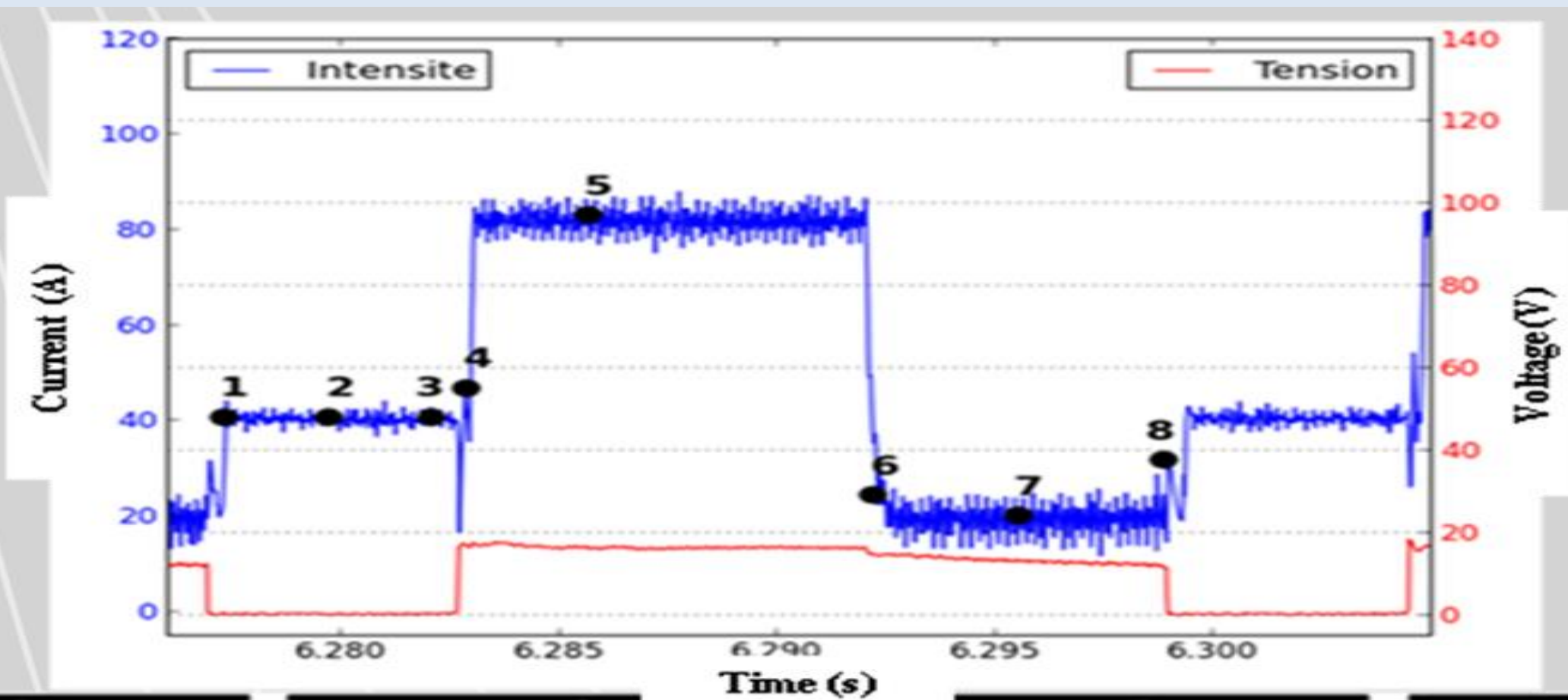
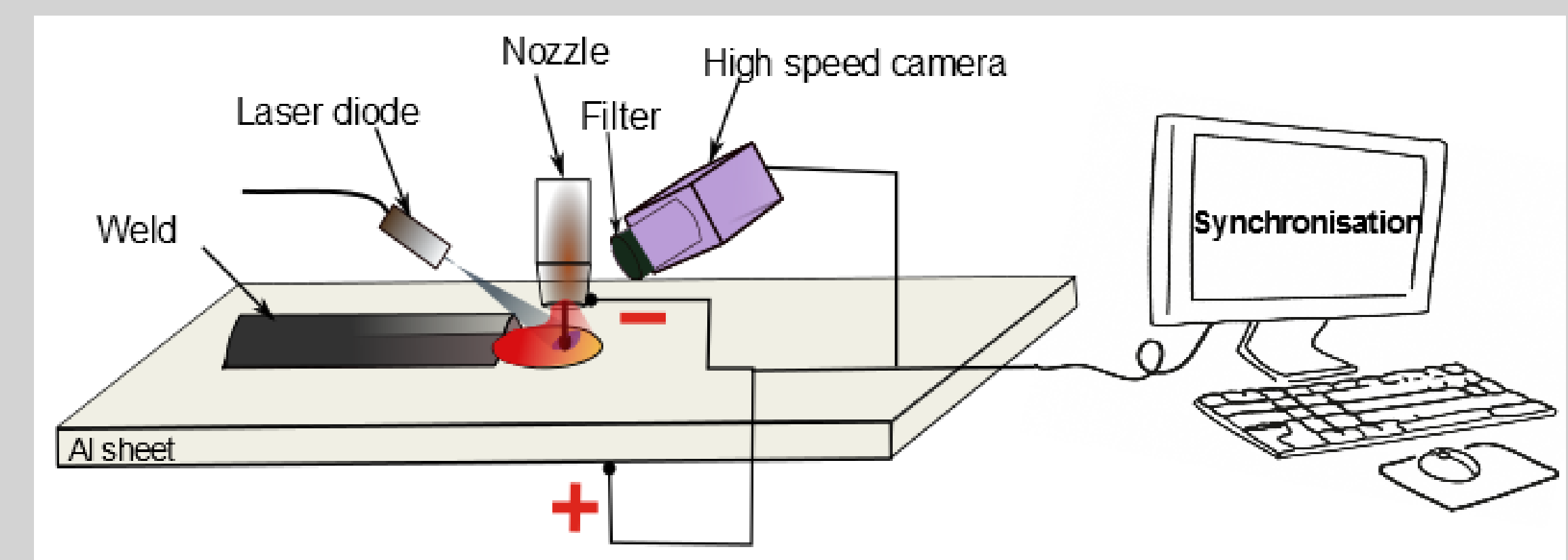
Understanding welding process operation mode is essential for choosing the right parameters providing good assemblies quality. For Gas Metal Arc Welding (GMAW), the transfer of molten metal is the main factor determining the operation mode of a process.

Cold Metal Transfer (CMT) is one of the new developed control metal transfer processes derived from the well-known GMAW. The principal innovation is the integration the motions of the filler wire into the overall control of the process to ensure a stable and regular transfer of the filler metal. The aim of this work is to study the metal transfer mechanisms of the CMT process and their dependence of the electrical waveform of welding.

EXPERIMENTAL PROCEDURES

Welding tests were conducted using a CMT power source and a monitoring system consisting of a high-speed camera with an interference filter and a green laser as an illumination source.

Experiments consist to deposit AISi₅ filler metal on aluminum sheet under pure argon as shielding gas. The current and voltage waveforms were captured by the corresponding sensors. Special control software was developed to synchronize the welding system, the image capturing system and the voltage and current recording.



Hot phase (red), **Cold phase** (green), **Short circuit phase** (blue)

Metal transfer cycle of the CMT process

The metal transfer cycle can be divided into three phases:

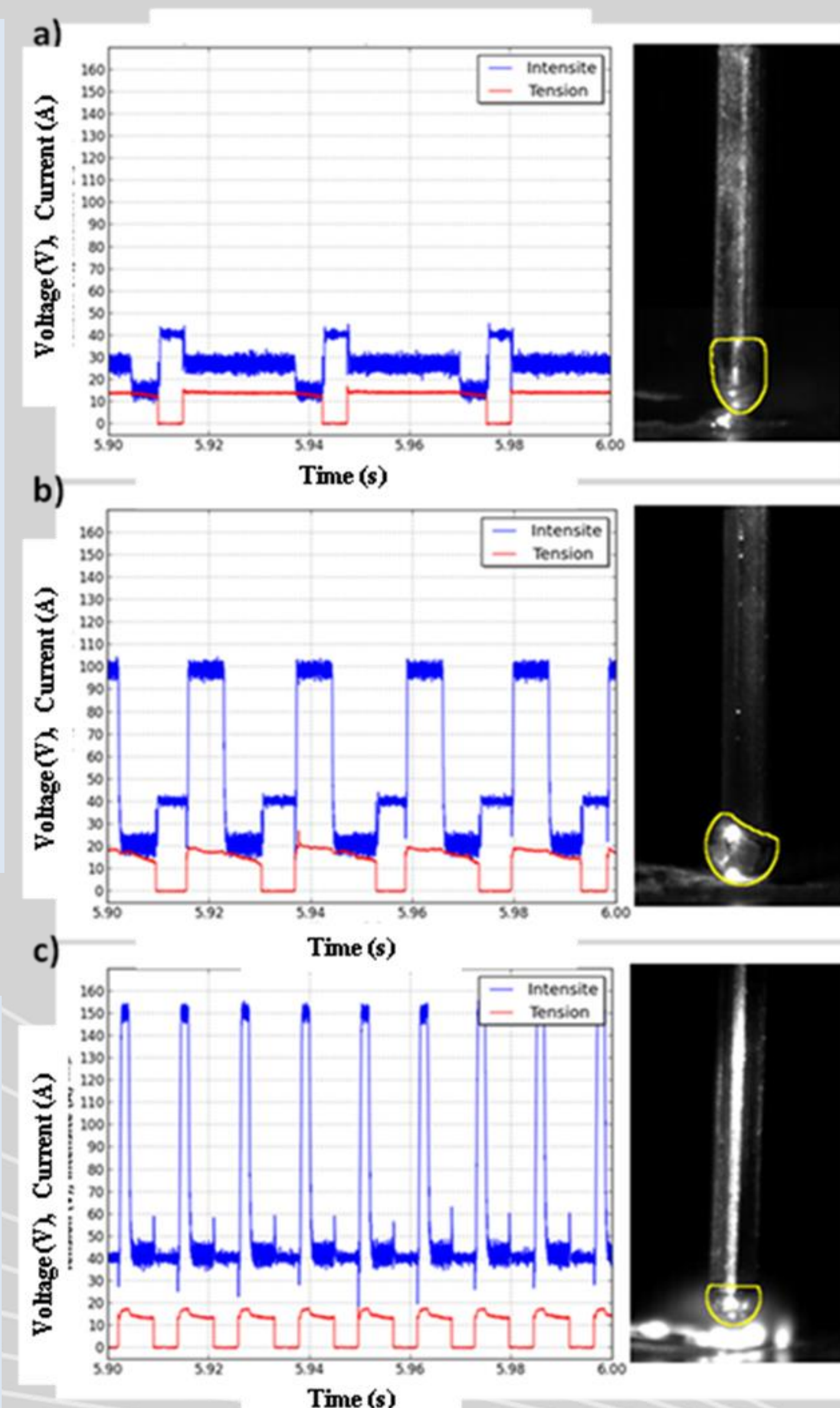
- 1) Hot arc phase:** an high power electrical arc allows the meting of a small droplet of molten metal at the end of the filler wire (image 1).
- 2) Cold arc phase:** the filler wire go down under a lower arc power until the molten metal droplet reach the weld pool, creating a short circuit (image 2-4).
- 3) Short circuit phase:** the filler wire is mechanically retracted (image 5), producing the pinching and the detachment of the molten metal droplet into the weld pool. The arc is then reignited and the cycle repeats (image 6).

Evolution of the current waveform

According to the process parameters, three types of waveform are formed leading to various transfer characteristics:

- a)** The first type is characterized by a very low current pulse and an important pulse duration. The droplet formed is very elongated and its diameter is same as the wire.
- b)** The second type corresponds to a higher current pulse with shorter pulse durations gradually as the intensity increases. The droplet adopts the spherical shape with a greater diameter than that of wire.
- c)** The third type corresponds to a waveform having very short pulses of constant intensity of 150 A. This waveform produces small droplets of almost hemispherical shape.

The last type of waveform produces the highest short circuit frequency and allows the most regular deposits for AISi5 filler metal.



Conclusion

The results of this study show the efficiency of the developed monitoring system for online monitoring of arc welding process. It is of particular interest for the study of the CMT process, that produces very complex current waveforms combined to the alternated feeding of the filler metal.

The huge variety of current waveforms allowed by the CMT process produces various transfer mechanisms, that lead to various quality of weld deposits, that can be observed and analyzed thanks to the monitoring system.

