Acoustic Emission Monitoring in the field of welding

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Acoustic emission monitoring (AEM) adds a new dimension to NDT of welds. The wide-ranging applications of acoustic emission monitoring are illustrated by examples of real-time data from submerged-arc, gas tungsten-arc and resistance spot welding.

Acoustic emission during resistance spot welding can provide information about the weld strength, the nugget size, the defects and the total length of the cracks [1,2,3,4,5]. There are a number of stages in the formation of a resistance spot weld, where acoustic signals are emitted. These can all be detected by a piezoelectric transducer, mounted on the electrode holder of the welding machine. Signals can be detected during the first electrode contact and during the lifting of the electrode, and further during expansion, recrystallization, solid-state transformations, plastic deformation, melting, evaporation, solidification, and sometimes when the weld cracks.

Examples of AEM applied to resistance welding were found in literature. Results for spot welding of DC01 showed the possibilities to optimise the welding parameters and to predict the weld quality. It was concluded that analysis of the acoustic emission provided useful information about the formation of the weld nugget. The AE measurements were found to be a better indicator for predicting splashes than the measured electrical and/or mechanical parameters.
Another advantage of the method is the prediction of a worn electrode. The method thus allows for improved spot welding control algorithms.

Literature shows that the AE signal can be used to monitor friction stir welding, in addition to the other commonly used control parameters [6,7,8,9].

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In [10], a development of an in-line quality control system for friction welding using AE techniques is described. As one of the most important results, it was confirmed that AEM can be reliably applied for the assessment of the quality of friction welds (weld strength) with a reliability of 95%.
Ref. [11] investigated the use of a non-contact, audio-based, acoustic sensor for monitoring bond integrity during friction welding of copper to stainless steel. By analysing the resonant frequency component of the audio signal, the authors were able to classify weld quality into three categories (acceptable, conditional, and unacceptable) according to the percentage of metallurgical integrity of the bonded interface.

A feasibility study for the application of AEM for gas-shielded arc welding was described in [12] (Figure 1). This study showed that AEM is suited for the control of the stability and quality of the welding process [13]. Furthermore, it was demonstrated that weld quality can be predicted for arc welding [14,15,16]. Other studies showed that AEM can also be used in laser welding [17,18,19].

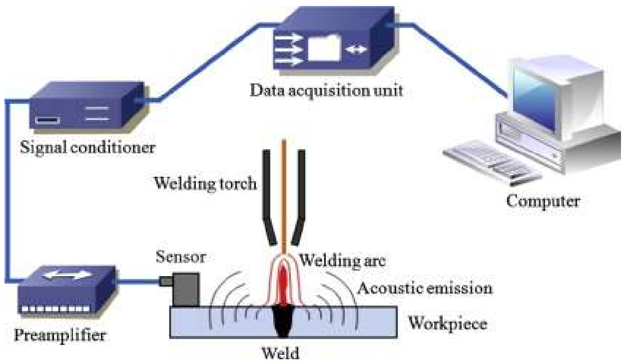

Figure 1: Schematic presentation of AEM for TIG welding

Summarising, by using the correct equipment and the associated analysis software, the different sources of acoustic emission can be distinguished and fulminating welding defects can be found.

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Cracks, porosity and inclusions can be detected in real-time. The ability to assign defect formation to dynamic conditions in a weld is illustrated by the measurement of crack development. In addition, sometimes it is possible to give an indication about the severity of the weld defect. In some processes such as resistance spot welding, it is also possible to determine the weld strength. Extensive literature search has shown, acoustic monitoring has not been examined so far for MPW or FSpW.