APPLICATION OF CMR-B-SCALAR SENSORS FOR ANALYSIS OF MAGNETIC PULSE WELDING PROCESSES AND WELDING QUALITY

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During the last decades it was demonstrated that magnetic field sensors based on nanostructured lanthanum manganite films exhibiting the colossal magnetoresistance (CMR) phenomenon could be used for high pulsed magnetic field measurement in very small volumes (10^{-2} mm^3). The output signal of these sensors does not depend on the magnetic field direction (CMR-B-scalar sensors) [1]. Such sensors were used for the measurement of magnetic diffusion processes in railguns [2-3] and magnetic field distribution in pulsed magnets [4]. In these experiments the pulse duration of magnetic field was 1-100 milliseconds. However, in some applications such as Magnetic Pulse Welding (MPW) of metal forming the significantly shorter magnetic pulses with high amplitude are used. The MPW is a collision welding process, which uses a high velocity impact to join two metals that are accelerated by short strong magnetic field. In this study, the possibility to apply CMR-B-scalar sensors for fast nondestructive method of quality evaluation of magnetic metal welding process was investigated [5]. The method, based on magnetic field dynamics measurements in the vicinity of welded metal and field shaper, was tested during electromagnetic compression and welding of aluminum flyer tube and steel parent. Experiments were performed at the TU Dortmund University. The testing bed used for the investigation of welding process is shown in Fig.1a. The experimental results and simulations demonstrated that during the deformation of the aluminum tube the maximum magnetic field in the gap between the field shaper and the flyer is achieved much earlier than the maximum of the current pulse of the coil and the first half-wave pulse of the magnetic field has two peaks (see Fig. 1b). It was obtained that the time instant of minimum between these peaks depends on the charging energy of the capacitors and is associated with the impact of the flyer with the parent. Together with the first peak maximum and its position, this characteristic could be an indication of welding quality. The results were confirmed by simultaneous measurements of the flyer displacement and velocity as well as numerical simulation of magnetic field dynamics. The relationship between the peculiarities of the magnetic field pulse and the quality of the welding process is discussed. It was demonstrated that the proposed method of magnetic field measurement during MPW could be used as a nondestructive method for monitoring of the welding process quality.

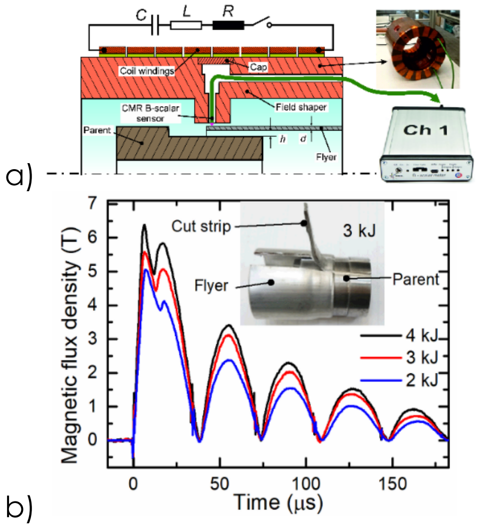

Fig. 1. Setup for magnetic pulse welding of tubes to cylinders with installed CMR-B-scalar probe for magnetic field measurement (a). Magnetic field between the field shaper and aluminum flyer tube at different charging energies (b). The inset presents a picture of the tested specimen after MPW.

References

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