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INFLUENCE OF THE CURRENT PULSE SHAPE IN SMALL-SCALE RESISTANCE SPOT WELDING OF A NICKEL ALLOY ON ITS MICROSTRUCTURE-RELATED PROPERTIES OF THE JOINTS

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The influence of various current pulse shapes in small-scale resistance spot welding of the nickel alloy plates 0.2 mm thick on its microstructure-related properties of the joints are presented. The first mode was a rectangular current pulse, the second one included the preheating stage, which was supplemented by a prolonged down slope in the third case (Fig. 1a).

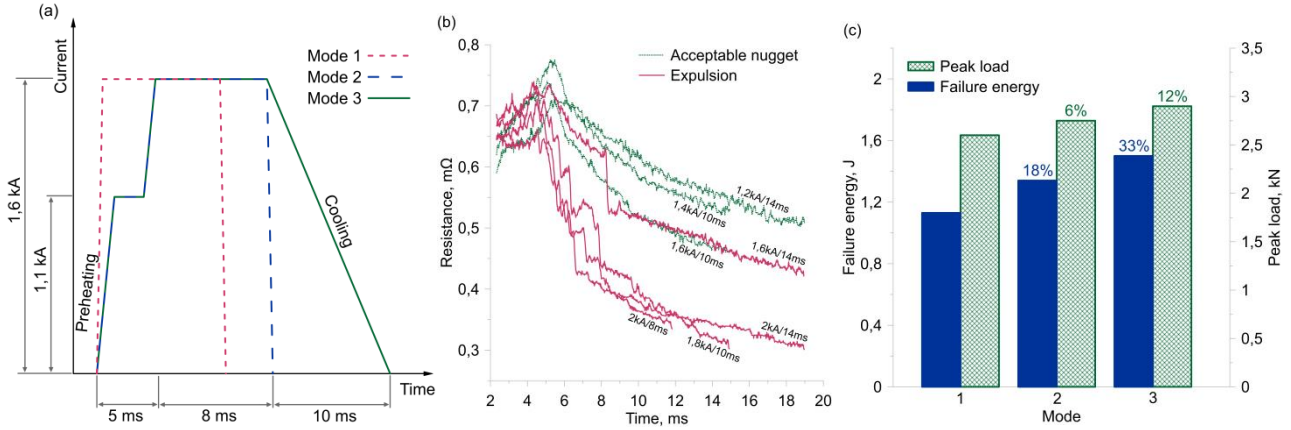

Fig.1. The welding current pulse shapes (a); sheet-to-sheet dynamic resistance curves (b); the corresponding tensile test results for the welded joints (c)

The mechanical properties of the welded joints were determined by tensile tests in accordance with [1, 2]. Vickers microhardness was measured along the diagonal axis of the nugget with a step between indentations of 50 μm. The microstructure was investigated using an optical microscope. Upon welding, the real current and voltage values were recorded using a digital oscilloscope.

Two types of the dynamic resistance curves were observed in the welding process (Fig. 1b). The optimal nugget sizes corresponded to a smooth decrease in the curves. Their sharp drop was recorded in the case of the metal expulsion. This result was consistent with the data reported by the authors [3], explained this phenomenon by the loss of the nugget material, shortening the current path.

The preheating stage stabilized heat input due to preliminary microroughness deformation and fracture of oxide films [4, 5], causing the sound weld and an increase in its failure energy by 18% (Fig. 1c). With a rectangular current pulse, cracks appeared in the cross section of the nugget. High cooling rates had inhibited volumetric diffusion that resulted in a non-equilibrium microstructure of the core metal. In this case, alloying elements were unevenly distributed in the nugget volume, affecting its tensile properties [6]. The prolonged down slope of the current pulse had reduced the solidification rate of the molten nugget metal. As a result, deviations of its final microhardness values from their average levels were reduced by about two times and the joint tensile strength was significantly improved.

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