On Monitoring the Resistance and Resistance Projection Welding Processes*,

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Introduction

Resistance Welding and its variants have long been available as industrial processes. In recent years, sensor and control technologies have become increasingly mature, allowing closed loop control of critical parameters, and comprehensive weld parameter data collection and storage, all of which have improved process quality control. Great strides have also been made in understanding the deceptively complicated physics of this straightforward process. Recent progress in resistance welding technology incorporates this technology into adaptive controllers employing neural net procedures. We propose a new approach to interpreting this wealth of information in order to obtain quality control metrics.

Procedure

A commercially-available 2kHz inverter-type DC power supply and matching electromagnetically-actuated welding head provided digital outputs for the four key welding parameters: current, voltage, electrode force, and electrode displacement. Additionally, the power supply was capable of feedback control of current, voltage or power, and the head capable of programmable force or weld-to-displacement control. We interpreted these measurements in a new way as a proposed method of process-based quality control. A resistance weld and a resistance projection weld between a thin Ni ribbon (0.125mm thick) and a much thicker Mo terminal for a battery application were analyzed.

Results and Discussion

Starting with data for the four key welding parameters, we explore the usefulness of presenting them in a derived format where the electrical work and power versus mechanical work and power are followed. This approach offers a new perspective in interpreting the process physics. While the mechanical power is three to four orders of magnitude less than the electrical, small changes in it due to subtle variations in electrode force, motion and geometry dramatically affect the final weld size and shape, making it analogous in some ways to the control signal for a high gain amplifier. By noting the amount and timing of the mechanical work relative to the electical work, we can make some important statements about whether the weld is proceeding as desired. Especially interesting periods are during the early stage of welding, when the interface resistance is being broken down, and during the forging phase, when maximal electrode motion takes place. We will discuss the signatures of normal and abnormal welds, compare the results of our measurements with simple model predictions, and finally, contrast the pros and cons of resistance versus resistance projection welds.

Conclusion

We present practical and theoretical frameworks for interpreting the results obtained by monitoring the interplay between electrical and mechanical modes of work during resistance welds and resistance projection welds, and discuss our new approach's usefulness in quality monitoring relative to existing methods.

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