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DESIGN OF THE RESISTANCE WELDING TOOL USING OPTIMIZATION TECHNIQUES

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ABSTRACT

Resistance welding is one of the most productive and economically competitive joining processes. It is widely applied in the manufacturing industry e.g. automotive, aerospace, electronics, electrical and other metal working industries for joining similar as well as dissimilar metals. Therefore there is great interest in understanding and designing the welding process; this encompasses understanding the chemical composition of the welded material, knowing the temperature distribution and predicting the formation of weld nugget.

The resistance welding process can be simulated with three coupled numerical models: an electrical model, a thermal model, and a mechanical model [1]. The FEM commercial software SORPAS takes these physical phenomena of the process into account by solving fully coupled time-dependent and nonlinear models (including contact, plasticity and temperature-dependent material properties). As well, the process can be simulated with good fidelity via a simplified FEM model using the software tool COMSOL.

The purpose of this study is to apply shape optimization tools for the design of resistance welding electrodes. A central industrial interest for the design of the resistance welding process is to obtain optimal electrode shapes in order to reduce wear etc, while maintaining good properties of the welds, for example measured in terms of weld nugget size (see Fig. 1). The design process is formulated as an optimization problem where the objective is to prolong the life-time of the electrodes, measured in terms of stress level and temperature level of the electrode. Welding parameters like current, time and electrode shape parameters are selected to be the design variables while constraints are chosen to ensure a high quality of the welding. Surrogate models based on a Kriging approximation has been used in order to simplify the calculation of shape sensitivities and to generate a generic tool that can be interfaced with other simulation tools [3, 4]. Example numerical studies show the potential of applying optimal design techniques in this area.

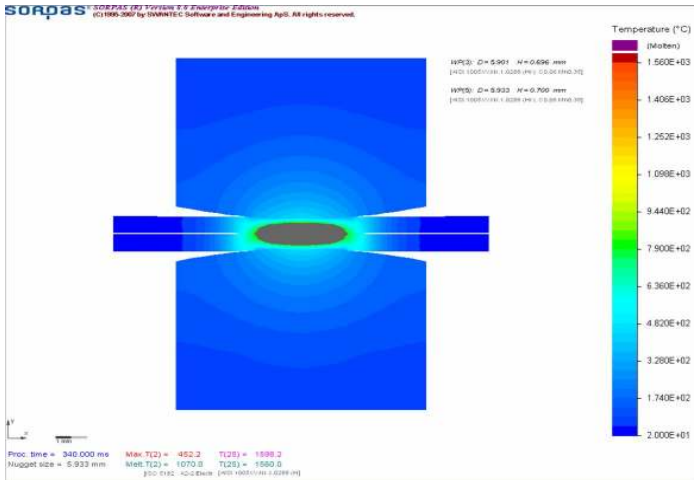

Figure 1. Melted Nugget - SORPAS Simulation

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