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Analytical model to predict the temperature evolution in Ultrasonic Welding/Joining

Description

The increasing demand for electrification is triggering fast paced research in technologies that enable durable and reliable connections, such as electrical wire harnesses in eVTOLs. Ultrasonic Joining is a friction-based process whereby high-frequency ultrasonic acoustic vibrations are locally applied to workpieces being held together under pressure. Quality joints are associated an optimum heat input delievered at the interface of the adjoined materials. However, due to the rapid nature of the processes measuring the temperature evolution is non-amenable experimentally.

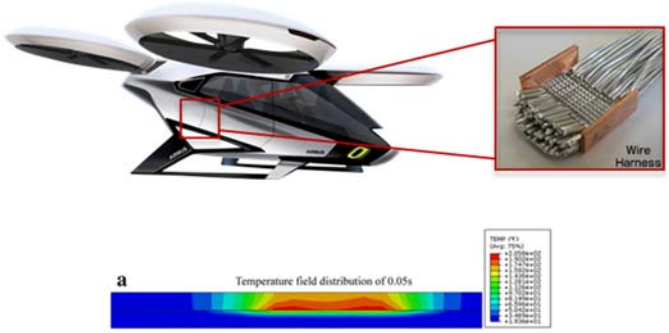

Figure 1 Example of the temperature evolution in Ultrasonic Joining[2].

The challenge envisioned by this work is to solve the 2D Heat Conduction Equation and establish relevant homogeneous and non-homogenous boundary conditions (e.g. Dirichlet, Neumann) that satisfy the PDE. To this end, the solutions proposed by Carslaw and Jaeger[1] will be used as the basis to yield the transient temperature evolution of Ultrasonic Joining. Figure 1[2] depicts an example of the temperature evolution in Ultrasonic Welding/Joining.

The outlook of this work will be to use the developed „white box“ model and couple with data-driven „black box“ models to generate the so called „hybrid models“.

Organisation

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Additional Information

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[1] Carslaw, H. S., & Jaeger, J. C. (1959). Conduction of heat in solids. Oxford: Clarendon Press.

[2] Zhao, D., Ren, D., Zhao, K. et al. Ultrasonic Welding of Magnesium–Titanium Dissimilar Metals: A Study on Thermo-mechanical Analyses of Welding Process by Experimentation and Finite Element Method. Chin. J. Mech. Eng. 32, 97 (2019). https://doi.org/10.1186/s10033-019-0409-8