Computational and Experimental analysis of Oxide Layer Propagation in Friction Stir Welding

Narges Dialami [1, a)], Miguel Cervera [1, b)], Michele Chiumenti [1, c)] and Antonio Segatori [2, d)]

[1] *International Center for Numerical Methods in Engineering (CIMNE), Universidad Politécnica de Cataluña, Campus Norte UPC, 08034 Barcelona, Spain;.*
[2] *Hydro, Innovation & Technology - Europe Extruded Solutions, Finspang, Sweden..*

[a)] Narges@cimne.upc.edu
[b)] Miguel.Cervera@upc.edu
[c)] Michele@cimne.upc.edu
[d)] Antonio.Segatori@ hydro.com

Abstract. This work studies computationally and experimentally the joint line remnant defects emerging in Friction Stir Welding (FSW) due to oxide layer propagation into the weld.
A finite element-based model is used for the computational simulation [1]. To follow the evolution of the oxide layer originally placed between the butted surfaces, a material tracing technique is incorporated in the numerical model [2]. This approach allows tracking the position of the tracers representing oxide layer particles knowing the nodal velocities.
A robust and fast two-stage numerical strategy is adopted for the analysis of FSW process to solve the underlying thermo-mechanical problem [3]. The first stage is a speed-up stage solved on a fixed mesh that allows to quickly obtain the steady state. Oxide layer evolution is traced in the second stage where the rotation of the tool is modelled.
Experimentally, to produce a clearly dispersed oxide line in the weld, one of the workpieces is anodized while the other one is taken as extruded.
The computationally obtained oxide layer patterns are compared to those obtained experimentally using macrograph analysis of the joint cross section. The effect of the pin features and the process parameters on the final result is studied. The results show that with appropriate modelling of the material tracers in FSW, significant agreement can be attained between the computed and measured post-FSW oxide layer evolved results.

References

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