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# LARGE SCALE COMPUTATIONAL HOMOGENIZATION USING THE FE$^2$ METHOD FOR CONTACT PROBLEMS

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Advanced High Strength Steels (AHSS) provide a good combination of both strength and formability and are therefore applied extensively in the automotive industry, especially in the crash relevant parts of the vehicle. Dual-phase (DP) steel is an example for such an AHSS, which is widely employed. The excellent macroscopic behavior of this steel is a result of the inherent micro-heterogeneity and complex interactions between the ferritic and martensitic phases in the microstructure. Thus, considering the microscale is indispensable for realistic simulations. This can be accomplished efficiently using the homogenization approach FE$^2$.

We present our software package FE2TI, which combines a highly scalable implementation of the FE$^2$ approach with FETI-DP (Finite Element Tearing and Interconnecting - Dual Primal) methods, i.e., scalable implicit finite element solvers based on a domain decomposition approach. On a macroscopic level, a contact implementation enables realistic simulations of deformation processes of dual-phase steels. Large contact simulations as well as parallel scalability to more than 1 million MPI ranks are presented. We also use FE2TI to perform the Nakajima test for a dual-phase steel in silico, considering the microscopic structure of the material. The Nakajima test is a well-known experimental test to compute an FLC (Forming Limit Curve), which is used to evaluate the strength and ductility of a material. The large-scale contact simulations for the virtual Nakajima test have been performed on the JUWELS supercomputer (Forschungszentrum Jülich, Germany). The finally obtained virtual FLC is presented and discussed in this talk.

## REFERENCES

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