Putting Mechanical Content in DVC: Toward 4D Mechanical Correlation

François Hild, Amine Bouterf, Ludovic Chamoin, Hugo Leclerc, Florent Mathieu, Jan Neggers, Florent Pled, Zvonimir Tomičević, Stéphane Roux

Putting Mechanical Content in DVC: Toward 4D Mechanical Correlation

F. Hild[1], A. Bouterf[1], L. Chamoin[1], H. Leclerc[1], F. Mathieu[1], J. Neggers[1], F. Pled[2], Z. Tomičević[1,3], S. Roux[1]

[1] LMT, ENS Cachan / CNRS / Université Paris-Saclay
61 avenue du Président Wilson, Cachan, France
Email: firstname.lastname@lmt.ens-cachan.fr

[2] Université Paris-Est, Laboratoire Modélisation et Simulation Multi Echelle MSME
UMR 8208 CNRS, 5 boulevard Descartes, Marne-la-Vallée, France
Email: florent.pled@univ-paris-est.fr

[3] Department of Engineering Mechanics, Faculty of Mechanical Engineering and Naval Architecture, University of Zagreb, Lučića 5, Zagreb, Croatia
Email: ztomicevic@fsb.hr

The goal of the present study is to illustrate the full integration of sensor and imaging data into numerical procedures for the purpose of identification of constitutive laws and their validation. The feasibility of such approaches is proven in the context of *in situ* tests monitored by tomography. The bridging tool consists of spatiotemporal (i.e., 4D) analyses with dedicated (integrated) correlation algorithms.

A tensile test on nodular graphite cast iron sample is performed within a lab tomograph. The reconstructed volumes are registered by resorting to integrated digital volume correlation (DVC) that incorporates a finite element modeling of the test, thereby performing a mechanical integration in 4D registration of a series of 3D images. In the present case a non-intrusive procedure is developed in which the 4D sensitivity fields are obtained with a commercial finite element code, allowing for a large versatility in meshing and incorporation of complex constitutive laws. Convergence studies can thus be performed in which the quality of the discretization is controlled both for the simulation and the registration.

Incremental DVC analyses are carried out with the scans acquired during the *in situ* mechanical test. For DVC, the mesh size results from a compromise between measurement uncertainties and its spatial resolution. Conversely, a numerically good mesh may reveal too fine for the considered material microstructure. With the integrated framework proposed herein, 4D registrations can be performed and missing boundary conditions of the reference state as well as mechanical parameters of an elastoplastic constitutive law are determined in fair condition both for DVC and simulation.